AN EMPIRICAL TEST OF CONTEXT-SPECIFIC SAFETY CLIMATE MEASUREMENT: A COMPARISON OF FIVE RESEARCH LABORATORY SAFETY CLIMATE MEASURES TO A GENERAL MEASURE OF SAFETY CLIMATE

A Thesis

by

NATHANAEL KEISER

Submitted to the Office of Graduate and Professional Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

Chair of Committee,	Stephanie C. Payne
Committee Members,	Winfred Arthur, Jr.
	Mindy E. Bergman
	M. Sam Mannan
Head of Department,	Douglas W. Woods

August 2015

Major Subject: Psychology

ABSTRACT

Safety climate researchers include both general and contextualized items in their safety climate measures. However, the relative value of including contextualized items in the prediction of safety outcomes is an empirical question that has not been rigorously tested. Theories about language comprehension and ambiguity indicate that context facilitates meaning. Additionally, memory theories and corresponding empirical research indicates that context facilitates recall. By excluding contextual information, general safety climate measures might provide a comparatively deficient assessment of the underlying construct as indicated by weaker relationships with various safety-related constructs (e.g., safety knowledge, injuries, etc.). In the current study, 757 university laboratory personnel completed a contextualized safety climate measure (i.e., chemical, biological, animal, or human subjects/office research laboratory), a general safety climate measure, and measures of a number of other safety-related constructs. In addition, because some safety climate dimensions appear more conducive to specificity (e.g., safety equipment & housekeeping, co-worker safety practices, and safety training) than others (e.g., management commitment to safety), item level analyses were also conducted. Hypotheses were tested by contrasting the contextualized vs. the general safety climate correlations with various safety outcomes. Only the contextualized human subjects/office laboratory measure was consistently more strongly related to the predictors than the general safety climate measure. The results suggest that contextualized information might facilitate comprehension and recall for individuals who work in less (rather than more) safety-salient contexts. Item-level analyses indicate that contextualization for the rewards safety climate dimension is particularly helpful. The results

of this study provide a rigorous test of contextualized measure effectiveness; however, further research is warranted to explicitly test the underlying theory and boundary conditions under which contextual information is beneficial.

ACKNOWLEDGEMENTS

I would first like to thank my committee chair, Dr. Stephanie Payne, for her help and guidance throughout this process. I would also like to thank my other committee members, Dr. Winfred Arthur, Jr., Dr. Mindy Bergman, and Dr. Sam Mannan, for their valuable insight along the way. I also extend my gratitude to the Mary Kay O'Connor Process Safety Center for funding my research and coursework these past two years.

Lastly, many thanks to my family and Elle for their love and support. I would not be here without them.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

A major tenet of workplace safety research involves effectively predicting and limiting workplace accidents and injuries. Unfortunately workplace injuries and deaths continue to plague organizations. In 2013, 4,405 workers were killed on-the-job and in 2012 nearly 3 million private industry employers reported nonfatal injuries and illnesses resulting in lost work days (U.S. Bureau of Labor Statistics, 2013a, 2013b).

There are a number of variables that contribute to workplace safety (e.g., leadership, personality characteristics, job attitudes, safety climate). This study focuses on safety climate[1]: employees' shared perceptions of the policies, procedures, and practices concerning safety, which is a robust predictor of safety outcomes (Beus, Payne, Bergman, & Arthur, 2010; Christian, Bradley, Wallace, & Burke, 2009; Clarke, 2006; Nahrgang, Morgeson, & Hofmann, 2011).

Safety climate is most frequently described as an antecedent of workplace injuries (e.g., Christian et al., 2009; Clarke, 2006). Safety climate research, however, includes both prospective and retrospective designs and analyses. Beus et al. (2010) proposed that safety climate is theoretically both a predictor *and* an outcome of workplace injuries. Safety climate influences behavior-outcome expectancies, leading to actual behavior and outcomes (Zohar, 2003). At the same time, safety climate perceptions are influenced by employees' reflection

[1]Many safety researchers use the term "safety culture" (e.g., Harper & Watt, 2012). Industrial/Organizational psychologists distinguish between organizational culture and organizational climate (Denison, 1996). Organizational culture is defined as shared assumptions, values, and beliefs that characterize an organization (Pettigrew, 1979). Organizational climate is differentiated from culture in its definition and reliance on perceptions of organizational policies, procedures, and practices. The current proposal focuses on safety climate as it is theoretically the more proximal situational variable to behavior that can be measured with a questionnaire.

on past incidents (Schneider & Reichers, 1983). The results of their meta-analysis support this proposition. They found differences in the relationship between individual and group-level safety climate and injury rates when differentiating between safety climate as a predictor and outcome (injury→group-level safety climate: $\rho = -.29$; group-level safety climate→injury: $\rho = -.24$; injury→individual-level safety climate: $\rho = -.16$). The current study examines self-reported safety outcomes as predictors of safety climate due to the convenience of gathering previous safety outcome data and organizational constraints preventing the collection of identified data that would facilitate linking of organizational records to survey data.

Multiple measures of safety climate exist in the multidisciplinary safety literature given its theoretical importance and empirical promise. An examination of the research literature reveals a proliferation of safety climate measures. Within these measures, there are general as well as industry-specific safety climate items. General items are supposedly relevant to employees working in any industry. Industry-specific items include risks, equipment, and/or procedures that are specific to the industry of interest. However, the extent to which industry-specific safety climate measures are more strongly related to safety-related constructs compared to a general safety climate measure is an empirical question that has yet to be rigorously tested.

Theories about the role of context in the memory retrieval process and the facilitation of comprehension support the hypothesis that workplace safety-related variables will predict industry-specific safety climate better than general safety climate. Industry-specific safety climate items incorporate contextual information which assists in the recall process by bringing autobiographical memories into conscious awareness. Additionally, they provide meaning for respondents to less-specific, and thus more ambiguous items.

Compared to industry-specific measures, general measures might be deficient assessments of safety climate because they are less effective at facilitating recall and comprehension. For example, a general item reads, “There is adequate safety training in my workgroup” (Beus, Munoz, Arthur, & Payne, 2013). This item lacks contextual cues to help respondents understand the meaning of the item and facilitate recall. In comparison, an industry-specific item incorporates the content of training or the ways in which personnel are trained in a particular context. For example, the general item listed above is contextualized in the present study for human subjects/office laboratories by incorporating examples of the content of training, including the standards and guidelines in the *TAMU Safety Manual: Office Safety*. Contextual information helps respondents better comprehend the item and facilitates recall of relevant experiences. Contextualized items are theorized to enhance the prediction of safety climate by safety knowledge, behavior, and safety-related events.

A recent survey of over 2300 laboratory personnel indicated that 46% of the respondents sustained one or more injuries while conducting research in a laboratory (Harper & Watt, 2012). The present study tests the value of assessing safety climate with a contextualized measure using a sample of university laboratory (lab) personnel. Due to the inherent differences between university labs, five laboratory-specific safety climate measures were developed: animal biological, biological, chemical, mechanical/electrical, and human subjects/office. These five measures will be referred to as context-specific measures hereafter.

The *purpose* of the present study is to provide a rigorous comparison of a context-specific safety climate measure to a general safety climate measure. The magnitude of the relationship between safety climate and multiple theoretically relevant variables will be compared when safety climate is operationalized with a general measure and when it is operationalized with a context-specific measure. The other variables examined in this study include safety knowledge, safety behavior (participation and compliance), injuries, incidents, and near misses. This study also provides an initial exploratory analysis of the conduciveness of seven safety climate dimensions to contextualization by conducting item-level analyses. The results will begin to inform researchers and practitioners about the value of using industry-specific safety climate measures compared to general measures.

The subsequent sections outline why a contextualized approach to safety climate measurement should result in stronger prediction by safety knowledge, behavior, and safety-related events. First, safety climate, its measurement, and contextualization are discussed. The theoretical impetus for contextualized measure effectiveness is then described followed by a review of the empirical research examining contextualization of other constructs. Following these sections, hypotheses are proposed concerning the magnitude of the relationship between safety climate and safety knowledge, behavior, and safety-related events when safety climate is measured with a context-specific measure compared to a general safety climate measure. Finally, a description of the current study is provided.

Organizational Climate

Organizational climate is commonly defined as shared employee perceptions of the formal and informal organizational policies, practices, procedures and routines (Ostroff, Kinicki, & Muhammad, 2012; Schneider, Ehrhart, & Macey, 2013). Organizational climate research supports the conceptual and empirical distinctiveness between climate and affective or evaluative individual reactions (Downey, Hellriegel, & Slocum, 1975; James & Jones, 1974; LaFollette & Sims, 1975; Rousseau, 1988; Schneider & Snyder, 1975).

Initial measures of organizational climate were inconsistent and ineffective as indicators of individually based outcomes such as satisfaction and job performance (Pritchard & Karasick, 1973; Schneider et al., 2013). The molar approach of measuring climate with 6 to 10 dimensions was too broad to predict specific individual outcomes. Schneider (1975) acknowledged the importance of specific climates that match the focus of predicted outcomes. Accordingly, there are currently a variety of specific climates and corresponding measures in the organizational science literature, including customer service (e.g., Schneider, Macy, Lee, & Young, 2009), empowerment (e.g., Chen, Lam, & Zhong, 2007), voice (e.g., Morrison, Wheeler-Smith, & Kamdar, 2011), initiative (e.g., Baer & Frese, 2003), and safety (e.g., Zohar, 1980).

Theoretically, organizational climate is a group-level construct. It describes shared perceptions of the environment, thus it reflects perceptions of multiple individuals within a workgroup, department, or organization. Organizational climate is commonly measured at the workgroup level by gathering individual workgroup member perceptions and then aggregating (averaging) them. When climate is measured at the individual employee level and not aggregated to the group-level, it is referred to as psychological climate (James, Hater, Gent, & Bruni, 1978). This study examines psychological rather than organizational climate due to organizational constraints inhibiting the ability to identify respondents within the same workgroup.

Safety Climate

Beginning with Zohar (1980), one of the most researched organizational climates is safety climate, which is defined as shared employee perceptions of safety policies, practices, and procedures (Zohar, 2003). Safety climate exists at all levels within an organization and encompasses the formal written policies and procedures as well as the informal unwritten practices that actually take place (Jex, Swanson, & Grubb, 2013). For example, the use of personal protective equipment might be required through a formal policy, but it might not be enforced and thus inconsistently followed. More recent conceptualizations of safety climate focus on the degree to which safety is a priority to the organization compared to other organizationally relevant behaviors and outcomes (e.g., speed, quality, quantity; Jex et al., 2013; Zohar, 2010).

Measurement of safety climate. A number of safety climate measures now exist in the safety climate literature. In their recent meta-analysis, Beus et al. (2010) identified 61 unique safety climate measures. In a follow-up systematic review of over 1500 items within these measures (Beus et al., 2013), 33 of the 61 measures included at least one industry-specific item (e.g., "Policies regarding not recapping used needles are posted;" Day, 1999), whereas 28 measures consisted of only general items (e.g., "A busy situation does not prevent supervisors from intervening if someone acts against safety rules;" Varonen & Mattila, 2000). Safety climate measures have been specified for a number of industries including: driving (Wills, Watson, & Biggs, 2006), aviation (Gaba, Singer, Sinaiko, Bowen, & Ciavarelli, 2003), remote workers (Huang et al., 2013), and medical contexts (Gershon et al., 1995) (see Table 1).

Zohar (2003, 2010) advocated for the development of industry-specific measures of safety climate as the next step in further understanding the safety climate construct. Zohar

Table 1

Examples of Industry-specific Safety Climate Items

Source	Context	Sample item
Gaba et al. (2003)	Naval aviation	"My command closely monitors proficiencies and currency standards to ensure aircrew are qualified to fly."
Huang et al. (2013)	Remote workers	"Provides trucks with the best safety equipment (back-up cameras, mirrors, bubble lights)."
Gershon et al. (1995)	Medical	"At my facility, medical waste is properly disposed of."
Wills et al. (2006)	Work-related driving	"Driver training is provided on skills specific to the type of vehicle driven for work."

(2010) contends that industry-specific measures hone in on those climate perceptions that are especially relevant to a particular industry. He used work-related driving as an example of an industry for which safety climate items have been developed. For example, the following item is included in a trucking safety climate measure: "My dispatcher insists that I do not use in-vehicle communication devices while driving". As this item indicates, industry-specific items frequently incorporate specific hazards that are relevant within a particular industry (e.g., needles, working at heights, sub-zero temperatures).

Zohar (2010) further argues that the identification of specific climate indicators enhances our ability to study climate emergence. He contends that responses to industry-specific safety climate measures provide more detailed information about what processes are most important in the emergence of safety climate. For example, the previous item ("My dispatcher insists that I do not use in-vehicle communication devices while driving") compared to a general item: “My company (Top management) is strict about working safely when work falls behind schedule” (Huang et al., 2013) might help identify the specific indicators most relevant to safety climate emergence in the truck driving industry. Incorporating industry-specific hazards and practices into survey items can be likened to adding contextual information to a narrative. As such, the revision of general items into industry-specific items can also be referred to as contextualizing items. Correspondingly, theory and research on contextualization explains why industry-specific measures of safety climate could be psychometrically preferable to general measures.

Contextualization

A thorough description of context and contextualization is necessary before delving into more detail surrounding industry-specific safety climate measures. Context is fundamental to the study of human behavior. A long-held and well-accepted psychological theory is the premise that behavior is influenced by the interaction between a person and the situation (Lewin, 1951). The situation is the context in which the behavior occurs. Context has been defined as “the historical, ethical, political, cultural, environmental, or circumstantial settings or conditions that influence and complicate the consideration of any issues, ideas, artifacts, and events” (Association of American Colleges and Universities, 2010, p. 1). According to this definition, context refers to a variety of events, settings, or conditions and is applicable to different research areas. For example, perception researchers study how context might trigger different perceptions of the same stimulus (e.g., Gregory & Gombrich, 1973). Memory researchers study context-dependent memory which is the well-established phenomena that the context in which something is experienced cues memory retrieval (e.g., Godden & Baddeley, 1975).

Contextualization is most simply defined as *the provision of context*. The contextualization of survey items can be conceptualized on a continuum based on how much context is incorporated within the item. At one end of the contextualization continuum are items which incorporate little to no context. For example, personality items did not initially include contextual information (e.g., “I like initiating conversations with people I do not know;” Mount & Barrick, 2007). In the middle of the continuum are items which incorporate contextual information, but for broad domains. For example, personality researchers refer to contextualization as specifying the focal context within the survey instrument. This is typically done by adding the phrase “at [context]” to the end of the item and/or in the instructions prior to completing a measure (Shaffer & Postlethwaite, 2012). Personality researchers have added “at work” (e.g., Schmit, Ryan, Stierwalt, & Powell, 1995), “at school” (e.g., Lievens, De Corte, & Schollaert, 2008), and “at home” (e.g., Heller, Ferris, Brown, & Watson, 2009) to personality measures and instructions. At the other end of the contextualization continuum are items which incorporate contextual information for a specific industry (e.g., trucking), job (e.g., welding), or organization. The most context-specific types of items incorporate such unique, context-dependent information that they are not relevant outside of that context. Industry-specific safety climate measures are an example of contextualized measures for more narrow contexts.

Testing the effectiveness of contextualized measures. This study seeks to determine the effectiveness of a contextualized approach to safety climate measurement. It is essential to first describe what a rigorous empirical comparison of a contextualized measure to a general measure might look like. To maximize internal validity and minimize possible confounds, the only thing that will vary between the contextualized and general measure is the inclusion of contextual information. Therefore, the number of items within each measure is the same. Also, the same sample of individuals will complete both measures as well as other safety-related constructs. This provides variables on which to compare the influence of the contextualized and general measures. To enhance external validity, multiple contextualized measures will be developed and examined. This study is designed accordingly.

Previous analyses of contextualized safety climate measures are described in the following sections and compared with the current study. The current investigation provides a more thorough and rigorous analysis of contextualized safety climate measurement.

Safety climate contextualization. Industry-specific safety climate measures are developed a number of different ways. Recognizing the importance of context, some researchers alter safety climate measures by simply selecting the items that appear most relevant in a particular industry (Glendon & Litherland, 2001; Lee et al., 2014). Other researchers develop safety climate measures by writing items that include important industry-specific safety equipment and policies identified in interviews and surveys with subject-matter experts (e.g., Huang et al., 2013). No specific technique to developing a contextualized or industry-specific measure has been systematically validated. As such, researchers develop industry-specific measures in whichever manner they deem appropriate.

In the current study, a general safety climate measure was contextualized by incorporating specific information relevant to the focal context and the core meaning of the items. The items were altered while ensuring they remained consistent with the theoretical definition of the safety climate construct and their corresponding dimensions. The focal context for the current study is university research laboratories. In this study, a research laboratory is defined as *a physical indoor space in which research is conducted including wet labs, computer labs, but not teaching labs*.

Contextualized measures were developed based on a review of relevant literature, including laboratory safety research (Harper & Watt, 2012; National Research Council, 2014), a handbook (Furr, 2000), and university manuals and inspection checklists (Michigan State University, 2014; The Ohio State University, 2014; Princeton University, 2014; Texas A&M University, 2009, 2012; Texas Tech University, n.d.; University of Texas at Austin, 2013; West Virginia University, 2012), as well as interviews with subject-matter experts. Five unique laboratory types emerged from the literature review: animal biological, biological, chemical, mechanical/electrical, and human subjects/office. Correspondingly, five contextualized measures of safety climate were developed. Relevant safety policies and risks were added to contextualize the items. For example, a general item, "My co-workers always follow safety procedures," was contextualized to a chemical laboratory by identifying and listing common safety procedures for this setting as bullets underneath the item.

My co-workers always follow safety procedures. This includes:

The use of PPE

- Wear appropriate clothes in the laboratory (i.e., closed toe shoes, laboratory coat/smock, and full-length shirts and pants)
- Don appropriate PPE when handling risky equipment, radioactive materials, and chemicals (e.g., chemical splash goggles, gloves, hot mitts, aprons, respirators, etc.).

Other standard chemical safety procedures:

- Use of fume hoods when working with chemicals, radioactive material, and any other material that releases hazardous aerosols.
- Store, label, and date chemicals appropriately.
- Dispose of waste properly.
- Respond and react to chemical spills and releases according to procedures.
- Do not eat in the lab and do not store food with laboratory specimens.
- Do not pipette by mouth.
- Safety handling and disposal of sharps.
- Decontamination of equipment and workspaces.

- Document safety-related issues and concerns.
- Operate equipment only after receiving necessary training.

In this study, general safety climate items previously deemed to be true to the definition of the safety climate construct (Beus et al., 2013) were revised to include context-specific information and context-relevant examples. The approach to developing and testing the value of contextualization taken in this study was intentionally systematic and rigorous. The only alteration to the contextualized measures was the addition of item-relevant context-specific information. Consequently, any statistical differences that emerge between the general and context-specific measures can be attributed solely to the provision of context. The effectiveness of the technique utilized in this study and sufficiency of the contextual information provided is determined empirically.

Previous efforts to examine the value of industry-specific safety climate involve generating completely new industry-specific measures and comparing their validity to a general measure (e.g., Huang et al., 2013). However, it cannot be determined if the observed differences between the two types of measures was due to (1) differences the nature of the items themselves, (2) the number of items, or (3) the provision of context. A more rigorous comparison (as utilized in the current study) only manipulates the variable of interest (i.e., context).

Empirical studies of industry-specific safety climate measures. A review of the literature identified only one study that has compared the criterion-related validities of an industry-specific safety climate measure to a general safety climate measure. Specifically, Huang et al. (2013) developed a 20-item truck driving organization-level safety climate measure as well as a 20-item group-level safety climate measure. They compared these measures to two 6-item general measures of organization- and group-level safety climate.

Their analyses were conducted at the individual-level because there was not sufficient agreement to justify aggregation to the group level or sufficient sample size to aggregate to the organization level. They tested the value of industry-specific measures based on their comparative prediction of self-reported driving behavior (measured concurrently with safety climate) and amount of lost work days in the 6-months following initial data collection (Huang et al., 2013). The organization and group-level general measures explained 14% and 10% respectively of the variance in self-reported driving behavior. The organization and group-level industry-specific scales explained an additional 6% and 11% respectively above and beyond the general measures. When predicting lost work days, only the general scales significantly predicted on their own (B = -0.31 and B = -0.21 for the organization and group-level scales, respectively). The industry-specific measures contributed to the prediction of lost work days only when the general measures were also included in the equation (B = -0.87 and B = -0.73 for the organization and group-level scales).

Considering the similarity of Haung et al.'s (2013) study to the current study, it is important to note the differences between the two, and how this study addresses the limitations of Huang et al.'s initial efforts. The current study differs from Huang et al. in a variety of meaningful ways. Huang et al. (2013) provide little theoretical explanation for the observed differences between industry-specific and general measures. This study seeks to explain the usefulness of contextualization based on comprehension and the recall process. The current study also develops and compares multiple contextualized measures, whereas Huang et al. (2013) developed two industry-specific safety climate measures for one industry. Additionally, this study includes an initial analysis of contextualization for seven dimensions of safety climate. Lastly, Huang et al. (2013) treated safety climate as a predictor of self-reported driving behavior in their analyses. In the current study, self-report outcome data measured concurrently are assessed as predictors of safety climate.

Practical advantages and disadvantages of contextualization. General and specific measures can also be differentiated based on their practical advantages and disadvantages. The practical advantages of general measures result from their broad applicability. That is, general measures by their very nature are applicable to people in different contexts. This allows for easy comparison, use, and analysis of measures.

For safety climate in particular, general measures are applicable to employees in different types of industries and organizations. For individual organizations, general measures are easier to use because the items do not need to be modified or new measures do not need to be developed. General measures permit normative and quantitative comparisons across organizations because of the commonality of items within an industry. That is, general measures can be used as a means of comparison, often called benchmarking, across organizations, or across different work groups or departments within an organization because they do not change as a function of the specific setting. Finally, general measures apply to a variety of industries and thus do not lead to a proliferation of specific measures that tend to result in contaminated measures.

Contextualization is common for applied scientists although not necessarily labeled as such. Consulting firms often advertise tailoring or customizing measures to meet the needs of an organization (e.g., ProAct Safety, 2012). This can include alterations to general measures or the development of new measures making them applicable to a particular industry or organization (i.e., contextualization). One notable reason for the continued use of contextualized measures in the applied sector is that they might generate more targeted and useful organizational feedback. A measure catered to an industry or organization might offer better diagnostic information because the specific items developed include more actionable information.

That being said, contextualized measures are difficult to develop because of the variety of relevant safety risks associated with a given industry. For example, university laboratory members work with myriad equipment and need to follow complex and detailed safety procedures. Even within one type of laboratory (e.g., animal biological), there can be considerable variability in the equipment used. It is not feasible to list all safety-related issues associated with a given laboratory and consequently it is imperative to identify and include the most important safety-related policies in a contextualized safety climate measure. Given these constraints, general measures tend to be comparatively easier to develop.

Relatedly, the addition of contextualized information increases the cognitive load of the item and the required reading level for the respondent, especially because contextualized items often incorporate complicated terms used in a given industry. Correspondingly, contextualized measures might take comparatively longer to complete. This might in turn lead to respondent fatigue. Additional disadvantages of contextualized measures that are addressed by general measures include the inability to compare across organizations and the proliferation of measures.

Theoretical Value of Contextualization

It is relatively common in organizational science for researchers to have differences in opinion about the best way to measure particular constructs and the level of specificity at which they should be measured (Schneider et al., 2013). There are a variety of practical trade-offs when it comes to using a general or specific approach. However, arguably the most important factor in determining whether to use a general or more specific approach relies on which is more useful. For many measures, and for safety climate in particular, the most important deciding factor is which approach is best predicted by or predictive of safety incidents. The theoretical value of contextualized measures is based on the idea that context facilitates comprehension and memory retrieval during the response process.

Comprehension. Language comprehension refers to the process of deriving meaning from linguistic information by resolving ambiguities (Hunt & Ellis, 2004; MacDonald, Pearlmutter, & Seidenberg, 1994). Researchers differentiate between syntactic and lexical processes and accompanying ambiguity. Syntactic processes involve identifying relationships between words based on sentence structure and grammar (Touragneau & Bradburn, 2010). Lexical or semantic processes involve determining the contextually appropriate meaning of individual words (MacDonald et al., 1994).

Syntactic and lexical ambiguity lead to errors in comprehension (Touragneau & Bradburn, 2010). Sentences can be misinterpreted or understood differently because of ambiguous grammar. For example, the sentence “flying planes can be dangerous” is interpreted differently if flying is interpreted as a verb or adjective (Touragneau & Bradburn, 2010). Although rare, syntactic ambiguity is not uncommon in survey research (Fillmore, 1999). Excessive grammatical complexity, including multiple and/or embedded clauses, can lead to working memory overload (Tourangeau & Bradburn, 2010).

The meaning of individual words can also be interpreted differently based on lack of knowledge or appropriate contextual information. Many survey items incorporate technical terminology, the meaning of which might not be known by all respondents (Tourangeau & Bradburn, 2010). More commonly used words can also be interpreted incorrectly if they are not contextually defined. For example, Belson (1981) found that people apply different age cutoffs to “children”. Response categories might also be ambiguous. For example, people differ in how they interpret “not too often” and “very often” (Schaeffer, 1991).

Context assists in lexical processing by providing contextual meaning to individual words. This is evident in language comprehension during daily interactions. In everyday communication people provide context by giving more detailed information or history about a circumstance in order for others to better understand a particular situation. For example, an individual might describe a car accident by first explaining where they were driving, what time of day it occurred, how many cars were on the road, etc. Similarly, inside jokes are those that are understood by only a few; historical context needs to be provided in order for an outsider to understand and “get” the joke. People respond to and understand a situation differently when they know the context of a particular event. For example, when an individual learns about a death in someone’s family, it is likely to be perceived quite differently if the mourner recently experienced a similar loss.

Memory and the retrieval process. Memory refers to the influence of past experiences on present thought and behavior (Hunt & Ellis, 2004; Hunter, 1957). The memory system is described as an information-processing model, which is based on encoding, storage, and retrieval (Melton, 1963). In order to remember something an individual needs to process the information in their brain, retain it for a period of time, and be able to retrieve it later (Melton, 1963).

Long-term memory refers to the brain’s storage mechanism and is categorized into semantic and episodic or autobiographical memory (Tourangeau & Bradburn, 2010). Semantic memory consists of information about vocabulary, language, and general knowledge about the world (Tourangeau & Bradburn, 2010). Autobiographical memory consists of stored information about individual events, common sequences of events, and extended life events (Conway, 1996; Schank & Abelson, 1977). These memories include individual experiences as well as experiences with others, including witnessing other people's behavior. Both of these experiences are likely to be recalled when completing a safety climate inventory.

Conway (1996) described autobiographical memory in three hierarchical levels according to specificity: life-time periods, general events, and event-specific knowledge. Life-time periods are the least specific category of memories. Knowledge of life-time periods encompass those goals and common activities, locations, and actions that represent each particular period. Contained within life-time periods are general events, which are more specific memories that include general knowledge of repeated events, extended events, and minihistories. At the most detailed level, individuals store knowledge of the content of general events, referred to as event-specific knowledge.

Long-term and working memory interact in the memory retrieval process (Tourangeau & Bradburn, 2010). Working memory refers to active cognitive processing of incoming auditory and visual information (Atkinson & Shiffrin, 1968). Working memory processes incoming information that people experience on a daily basis and makes sense of it by connecting it to long-term memory. When trying to remember something, as a person is likely to do when responding to a survey, information is moved from long-term memory to working memory, bringing the information into conscious awareness (Tourangeau & Bradburn, 2010).

Context is a key component of the memory process, serving as an influential aspect of encoding and retrieval. Events occur within context. Likewise, the memory of events is encoded within context (Ashcraft & Radvansky, 2013; Myers, 2014). Context serves as a linking mechanism within long-term memory. When an individual encodes an event, he/she also includes other bits of information (Ashcraft & Radvansky, 2013; Myers, 2014). This additional information can serve as a retrieval cue, defined as "any words, images, or emotions, etc. that activate or direct the memory search process" (p. 322; Tourangeau & Bradburn, 2010). Context helps in the retrieval process by moving long-term memories associated with a given context to conscious awareness (Tourangeau & Bradburn, 2010). This process involves controlled (i.e., trying to remember something) and automatic components. For example, when attempting to remember something, an individual might picture himself or herself in the same context that they experienced the event. This can also occur outside of awareness. For example, a song might activate past memories because of its connection to previous experiences.

In support of the value of context to retrieval are studies which indicate that recall is enhanced when an individual is put back in the context where they experienced something. This often refers to physical context. Scuba divers listened to word lists in two different settings and recalled more of the words when they were retested in the same place (Godden & Baddeley, 1975). This also includes the state in which a memory is encoded. Emotions which accompany events can serve as retrieval cues such that a memory is easier to recall when an individual is in the same mood (e.g., Fiedler, Nickel, Muehlfriedel, & Unkelbach, 2001).

Retrieval cues in survey research. Researchers assess the effects of questionnaire design and the addition of retrieval cues in order to enhance recall, focusing mainly on self-reports of factual information. The retrieval process takes time (Krosnick & Presser, 2010). It follows that increasing the time it takes respondents to complete items will lead to more accurate reporting (Krosnick & Presser, 2010). In one study, longer questions led to increases in the reporting of health events, chronic conditions, and sensitive behaviors (e.g., Bradburn et al., 1980). Specifically, Bradburn et al. (1980) found that recall of alcohol consumption was improved when they cued respondents with locations and social occasions that were associated with drinking. Likewise, Lessler, Tourangeau, and Salter (1989) found that people reported more dental visits when they provided respondents with a list of common reasons why people go to the dentist. Researchers have listed common types of assault to provide contextual cues (e.g., assault with any weapon: for instance, gun, knife, scissors) instead of asking if respondents were assaulted, which led to more complete recall (Biderman, Cantor, Lynch, & Martin, 1986).

Another retrieval method used in survey research is decomposition, which involves dividing a broad question into smaller parts (Krosnick & Presser, 2010). Cannell et al. (1989) improved reporting accuracy by decomposing health care visits into four types: overnight hospital stays; other times a doctor was seen; times a doctor was not seen, but a nurse or medical assistant was; and times a medical personnel was consulted by telephone. Mean and Loftus (1991) found that recall of health care visits and dating was improved when they decomposed generic memories with a calendar time line. Similarly, Belli, Smith, Andreski, and Agrawal (2007) found that providing personal calendars with key events in a respondent's life improved the reporting of other events. Other research has shown that checklists might be useful to decompose a question (Smyth, Dillman, Christian, & Stern, 2006).

Safety climate is a perceptual variable; thus the accuracy of the measurement of this construct cannot be verified with information from another source. However, various safety-related events like personally falling on a slippery shop floor, observing a coworker be disciplined for not wearing his/her personal protective equipment, and contributing to safety discussions in daily workgroup meetings can be verified by another source of data. These events are likely to be recalled and contribute to a respondent's assessment of safety climate. To the extent that contextual information within a survey instrument facilitates recall of safety-related events, safety climate assessments may be affected.

The survey response process. There are a variety of theories concerning the mental steps people undergo when responding to survey items (e.g., Cannell, Marquis, & Laurent, 1977; Thurstone, 1927; Tourangeau, 1984). According to Tourangeau and colleagues' (Tourangeau, 1984; Tourangeau & Rasinski, 1988) model which is reproduced in Figure 1, the response process consists of four major steps: (1) comprehension of the item; (2) retrieval of relevant information; (3) use of that information to make required judgments; and (4) selection and reporting of an answer. As noted, first the respondent must comprehend the item. In other words, it must be meaningful to the respondent. The following step in the response process involves retrieval of the relevant information that is prompted by the survey item. This step relies on accurate recall of memories of experiences. Thus, the item is assumed to trigger the retrieval process (Jobe, Tourangeau, & Smith, 1993). After recall, individuals form judgments in order to transform the information they have remembered into

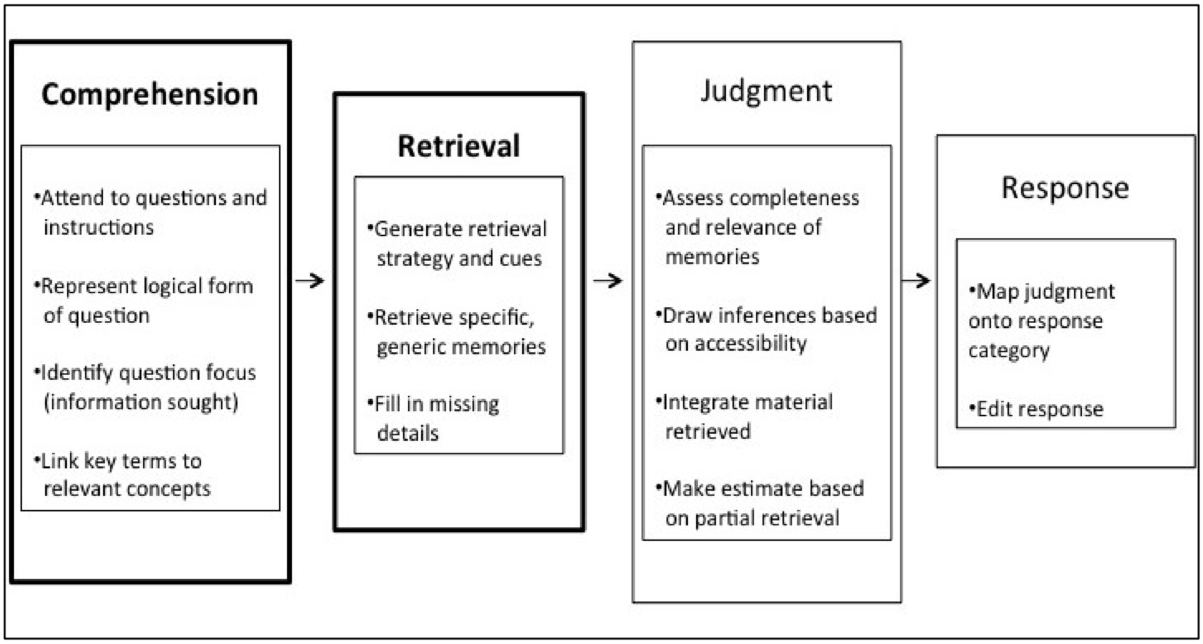

Figure 1. Components of the response process (Tourangeau et al., 2000, p. 8).

an appropriate response (Tourangeau, Ripps, & Raskinski, 2000). Individuals map their response onto the appropriate scale or option, considering consistency, acceptability, and a variety of other potential factors, and then choose a response option (Tourangeau et al., 2000).

There are a variety of other theories proposing models of the response process (e.g., Krosnick & Alwin, 1987). However, most theories, including the one presented by Tourangeau (1984), are fundamentally similar. Most theories incorporate memory and recall as essential to the response process. This implies that the extent to which the respondent is able to comprehend the meaning of an item and recall relevant memories is critical to the validity of their response. The following sections describe the application of comprehension, memory, and recall to the measurement of safety climate.

The response process, comprehension, memory, and safety climate. Respondents completing safety climate measures generally follow the response process described by

Tourangeau et al. (2000). They read and comprehend each item, retrieve relevant information specified within the item, make a judgment based on their retrieval, and select an answer that aligns with their perception.

Both general and industry-specific safety climate items prompt respondents to search their autobiographical memory for relevant experiences. For example, in a general safety climate measure, respondents are instructed to read statements and mark the response that indicates the degree to which they agree. A general item reads “employees in my workgroup are given sufficient safety equipment” (Beus et al., 2013). Individuals are prompted to recall the sufficiency with which safety equipment is provided. Upon reading the following industry-specific safety climate item, “My company (Top management) provides trucks with the best safety equipment (back up cameras, mirrors, bubble lights)” (Huang et al., 2013), respondents recall the degree to which the organization provides their trucks with back up cameras, mirrors, and bubble lights.

Despite similarity in the response process, contextualized and general items might facilitate comprehension and activate retrieval differently. Like context in a story, contextualized information provides meaning for respondents when they complete a survey. Specifically, context limits the lexical ambiguity associated with general items. For example, a general item reads, “my supervisor praises safe work behavior” (Beus et al., 2013). The words “praises”, “safe”, “work, and “behavior” might be lexically ambiguous because they can be understood to mean different things. Praising safe work behavior can refer to a variety of behaviors such as providing positive feedback, giving employees more discretion, and distributing awards. As such, individuals are likely to vary in what they infer the item to mean. Contextualized information addresses the ambiguity of general items by explicitly incorporating more detailed information to facilitate more consistent and accurate interpretation. General items are more ambiguous and consequently open to subjective interpretation.

The memory system is described as a network of linked concepts, which can be activated by context. Contextualized safety climate items should prompt information from autobiographical memory, bringing memories to conscious awareness. Put simply, respondents are more likely to remember relevant experiences when responding to contextualized items. General items should be less effective at assisting in the retrieval process because they incorporate fewer contextual cues. Respondents are unlikely to recall all relevant information and experiences when responding to general items.

Construct relevance. Ideally a measure is a perfect representation of the construct of interest. The overlap between the theoretical construct and its measure is referred to as construct relevance. Deficiency and contamination are two terms used to describe the degree to which a measure does not appropriately represent the construct domain space (Messick, 1995). Deficiency describes the extent to which a measure does not adequately and completely represent the construct domain space. Contamination describes the extent to which a measure assesses irrelevant information that is not a part of the theoretical construct. More construct relevant measures should be more predictive of theoretically relevant outcomes compared to measures that are deficient and/or contaminated.

In describing survey research that incorporates context, Krosnick and Presser (2010) note that "events characterized by uncued features are apt to be underreported relative to those with cued features" (p. 290). Safety climate items potentially cue respondents to recall and reflect on prior experiences concerning safety in their work environment. Compared to contextualized measures, general measures of safety climate are less likely to cue memories of specific events. For example, upon reading the following safety climate item “Equipment in my work area is checked to make sure it is free of faults,” respondents should reflect on the various types of equipment used in their workspace, the frequency with which it is checked, as well as the frequency with which it is determined to be free of faults. Without prompts or cues to remind them, individual respondents are less likely to recall all relevant experiences.

In contrast, contextualized safety climate measures that cue respondents to think about specific risks and issues might display stronger relationships with safety outcomes because of more construct-relevant responding. For example, a contextualized item reads, “Equipment in my lab is checked to make sure it is free of faults” and is followed by a list of equipment likely to be used in the respondent’s lab. By listing the specific equipment used in the focal environment of interest, respondents might be reminded of specific equipment and experiences, and therefore provide a more construct relevant response.

Specificity in other psychological measures. Measure contextualization for psychological constructs is not a new concept. Despite notable differences between previously contextualized constructs and safety climate, research tends to indicate that contextualization is beneficial. For instance, researchers have demonstrated the value of contextualizing measures of locus of control and the Big Five personality traits.

Spector (1988) defined locus of control as “a generalized expectancy that rewards . . . are controlled either by one’s own actions (internally) or by other forces (externality)” (p. 335). General measures of locus of control displayed modest relationships with work-related outcomes (Spector, 1988). Contextualized measures were developed to better predict work outcomes. Work locus of control is a context-dependent construct that is bounded by the rewards or outcomes (e.g., promotion, pay) in the work setting (Spector, 1988). Research generally supports the heightened relationships between work locus of control and work outcomes compared to general measures of locus of control.

Much like locus of control, personality inventories consist of primarily general items that have low criterion-related validities with job performance. The cognitive-affective system theory is based on the premise that behaviors are contextually specific and are better predicted when people are given a context, or frame-of-reference (Lievens, De Corte, & Schollaert, 2008; Mischel & Shoda, 1995; Wright & Mischel, 1987). The contextualization of personality measures has improved the criterion-related validity of personality inventories as predictors of job performance (Bing, Whanger, Davison, & VanHook, 2004; Hunthausen, Truxillo, Bauer, & Hammer, 2003; Lievens et al., 2008; Schmit et al., 1995). In a recent meta-analysis of the frame-of-reference effect, Shaffer and Postlethwaite (2012) found that personality measures altered to cue the work context have greater validity when predicting job performance. Contextualized measures of Conscientiousness ($\rho = .30$ vs. $\rho = .22$), Emotional Stability ($\rho = .27$ vs. $\rho = .11$), Extraversion ($\rho = .25$ vs. $\rho = .08$), Agreeableness ($\rho = .14$ vs. $\rho = .10$), and Openness to Experience ($\rho = .14$ vs. $\rho = .02$) had greater predictive validity than general measures.

In summary, the previous discussion provides theoretical support for the contextualization of safety climate measures based on item ambiguity, language comprehension, and memory and recall during the response process. This will be tested by comparing how safety climate relates to six safety variables when it is operationalized with a general measure compared to a contextualized measure.

Hypothesis 1: A contextualized safety climate measure will have a significantly stronger positive relationship with (a) safety knowledge and (b) behavior than a general safety climate measure.

Hypothesis 2: A contextualized safety climate measure will have a significantly stronger negative relationship with (a) injuries, (b) incidents, and (c) near misses than a general safety climate measure.

Further Evidence for the Value of Safety Climate Item Contextualization

Dimensions of safety climate. Although safety climate researchers tend to agree on the definition of safety climate and its multidimensional nature, there is not universal consensus on the number and nature of those dimensions. The number of dimensions included in various safety climate measures ranges from one (e.g. Neal & Griffin, 2006) to twelve (Krispin, 1997). The following safety climate dimensions were recently rated by subject matter experts as neither contaminated nor deficient: management commitment to safety, safety communication, co-worker safety practices, safety training, safety involvement, safety rewards, and safety equipment & housekeeping (Beus et al., 2010). Correspondingly, Beus et al. (2013) developed a general measure of safety climate that includes these seven dimensions. Definitions and example items for each dimension appear in Table 2.

The inclusion of context in a safety climate measure is based on the premise that the information associated with an industry is unique and important to acknowledge. Some safety climate dimensions lend themselves to contextualization more so than others. For example, industry-specific practices can be easily added to the co-worker safety practice dimension. In contrast, rewarding safety behavior is not likely to look all that different from one industry to the next. Safety climate dimensions conducive to contextualization are

Table 2

Safety Climate Dimensions, Definitions, and Sample General Items.

Dimension	Definition	Sample item
Management commitment to safety	The extent to which employees perceive that their supervisor is dedicated to providing a safe workplace.	"My supervisor takes a proactive stance when it comes to safety."
Safety communication	Perceptions of the effectiveness of communication concerning safety.	"Safety problems are openly discussed between my supervisor and my workgroup."
Co-worker safety practices	Perceptions of the extent to which employees' fellow co-workers are committed to safety.	"My co-workers always follow safety procedures"
Safety training	The extent to which employees perceive that the safety training is sufficient.	"There is adequate safety training in my workgroup."
Safety involvement	The extent to which employees perceive that they are involved in workplace safety.	"My supervisor promotes employees' involvement in safety related matters."
Safety rewards	The extent to which employees perceive that organizational leaders support safety behavior.	"My supervisor rewards safe behaviors"
Safety equipment & housekeeping	The extent to which employees perceive that they have been provided proper safety equipment and the working conditions are maintained to ensure safety.	"My supervisor provides safe working conditions"

Note. From Beus et al. (2013).

expected to show even stronger relationships with safety outcomes than safety climate dimensions that are less conducive to contextualization. The safety climate dimensions hypothesized to be most suited to contextualization are safety equipment & housekeeping, co-worker safety practices, and safety training.

Safety equipment & housekeeping. The types of safety equipment used and the importance of housekeeping is largely a function of the inherent and specific risks on the job. Equipment varies extensively from personal protective equipment like gloves, goggles, and boots, to hazard signs and splash guards. Housekeeping is about keeping the environment clean, safe, and limiting hazards on the job like mopping up spilled water and properly storing equipment to extend its lifetime as well as prevent harm to workers.

Co-worker safety practices. The co-worker safety practices dimension captures workgroup norms concerning safety behavior. For example, co-worker safety practices include wearing appropriate personal protective equipment, obtaining permits to conduct dangerous work, and refusing to deviate from specific safety procedures (e.g., always wearing a harness when working at heights). The most relevant co-worker behaviors concern following or not following safety policies, practices, and procedures, which are a function of the job-specific risks and hazards. Thus, survey items within this dimension seem suited for item contextualization.

Safety training. The content of safety training is inevitably a function of the specific risks and hazards on the job; thus this safety climate dimension is also expected to be conducive to contextualization. The safety training dimension concerns the extent to which safety training is made available to the people who need it and when they need it, the adequacy and appropriateness of the training content relative to the risks and hazards on the job, and how seriously training is taken by management and employees within the organization.

Safety communication. It is unclear if communication, rewards, and involvement are more or less conducive to contextualization. Communication items capture the extent to which information is flowing, employees are kept informed, and the timeliness of communication concerning safety. Communication is critical to safety climate because it is the primary means by which employees are made aware of the other dimensions like the priority of safety, rewards for safe behavior, and opportunities for involvement. The specific means by which companies convey information might be unique (e.g., meetings, signs, memos, newsletters) and thus the communication dimension might benefit from contextualization.

Safety rewards. Rewarding safe behavior items capture the extent to which there are incentives for behaving safely. On the one hand, rewarding safe behavior seems to be rather generic and does not warrant contextualization. On the other hand, the way each organization rewards safe behavior can vary and therefore lend itself to item contextualization, should that information be made available.

Safety involvement. Employees can be involved in organizational safety a number of different ways. For example, some organizations have safety committees, safety officers or representatives who are volunteers or elected by their peers, and/or opportunities to make anonymous suggestions about safety. The extent to which organizations make formal efforts to facilitate employee involvement in safety is likely to be related to the inherent risk of the work and thus, more prevalent in certain industries. However, the general notion of seeking employee input is not contextualized, so this dimension might be less conducive to contextualization.

Management commitment to safety. The management commitment to safety dimension of safety climate is a broad dimension that seems least conducive to contextualization. This dimension concerns the extent to which management prioritizes safety over other competing organizational priorities like productivity. It captures the extent to which management invests in the resources necessary to be safe like personal protective equipment and other safety equipment and their responsiveness to safety concerns, issues, and problems. This dimension consistently emerges as a core dimension of safety climate (e.g., Flin et al., 2000) and has been proposed to be a higher order dimension of safety climate (Beus et al., 2013). Based on the previous discussion, those safety climate dimensions that align most closely with specific policies, practices, and procedures should have a comparatively stronger relationship with safety-related variables. However, the current study only utilizes one general item from each dimension with an additional item for management commitment and safety equipment & housekeeping. As such, the current investigation seeks to describe patterns of the relationship between dimensions and outcomes for general and contextualized measures rather than test specific hypotheses.

Research Question 1: Are some safety climate dimensions more conducive to contextualization than others as indicated by their relationships with (a) safety knowledge, (b) safety behavior, (c) injuries, (d) incidents, and (e) near misses?

The Current Study: University Research Laboratory Safety

This study utilizes a university research laboratory sample to examine contextualized and general safety climate measurement. The following section provides an overview of the risks associated with research laboratories and contextualized measure development for five laboratory types.

Assessments of safety climate within the university laboratory environment are limited despite the occurrence of numerous accidents and injuries (Wu, Chen, & Li, 2008). In a 2012 survey of 2,374 laboratory personnel, 46% indicated that they had sustained at least one injury during their time working in a laboratory (Harper & Watt, 2012). Recent cases of safety accidents and injuries at university laboratories also highlight the importance of safety. Some of the most widely publicized took place at the University of California Los Angeles in 2008 (1 death), Texas Tech in 2010 (1 severe injury), and Yale University in 2011 (1 death) (National Research Council, 2014). It is important to acknowledge that laboratories exist beyond colleges and universities meaning that our results will generalize to laboratories in other settings (e.g., Los Alamos National Laboratory, Fermi National Accelerator Laboratory).

University laboratory personnel are exposed to toxic chemicals, electrical hazards, sources of radiation, and biological agents, among other potential hazards (DeRoos, 1977). As a result, the Occupational Safety and Health Administration (OSHA) instituted research laboratory standards including communication of laboratory hazards, the personal protective equipment standard, the eye and face protection standard, and the respiratory protection standard (Occupational Safety and Health Administration, 2012). They also instituted a specific set of standards concerning hazardous chemicals (Occupational Exposure to Hazardous Chemicals in Laboratories, 1990). A variety of additional references have been published for more current and specific laboratory safety issues (e.g., U.S. Department of

Health and Human Services' *Biosafety in Microbiological and Biomedical Laboratories*), which are used by institutions to develop individualized laboratory safety manuals.

Furr's (2000) handbook on laboratory safety offers a comprehensive summary of the multitude of safety procedures associated with laboratories across academic disciplines and settings. Furr (2000) categorized laboratory safety into two broad domains: chemical and non-chemical laboratories. Chemical laboratories are those that primarily work with potentially hazardous chemicals. Non-chemical laboratories include biological as well as animal biological laboratories. Furr (2000) also summarized safety for radioisotope, x-ray, laser, and recombinant DNA laboratories. Many of these additional facilities/laboratories are subsumed within chemical, biological, and animal biological laboratories.

Contextualized measurement development. Three contextualized measures were developed based on Furr's (2000) categorization of the three laboratory types (chemical, biological, and animal biological laboratories). His categorization of laboratories, however, omits mechanical/electrical (e.g., physics, mechanical engineering) and human subject/office laboratories. As such, two additional contextualized measures were developed based on university laboratory manuals, interviews with laboratory personnel, and tours of local laboratories. A generic or uncategorized measure was also developed, which combines all the unique elements of the five lab-specific measures into one measure. The generic measure was developed for the sole purpose of giving respondents who did not classify themselves into one of the five laboratories a contextualized measure to complete.

There were two other options for categorizing and developing laboratory-specific safety climate measures: developing one general laboratory-specific measure or developing contextualized measures based on academic subject. The first option does little to acknowledge the variety of unique safety issues in particular laboratories. The second option involves the development of numerous measures, many of which would not be meaningfully different. A compromise between these two options was chosen based on five categories that acknowledge unique and meaningful differences in risks, hazards, equipment, and safety-related policies.

2. METHOD

Sample

Laboratory personnel across the variety of laboratories at Texas A&M University were contacted and asked to participate. There are over 3,000 laboratories regulated by environmental health and safety (EHS) and biosafety at Texas A&M University, which encompass a number of different academic disciplines including biology, chemistry, physics, and engineering. The EHS laboratory safety, industrial hygiene, and biosafety groups oversee laboratory safety at Texas A&M University. The industrial hygiene and biosafety group work within EHS ensure that safety practices are implemented and utilized and that international, national, and state safety standards are followed. Additionally, they develop and implement safety policies and protocols, inspect labs, report results, and provide safety training.

As a brief overview of the structure of EHS, the Laboratory Safety Committee is in charge of recommending and developing policy, guidance, and safety manuals applicable to laboratory safety. Academic/college deans are responsible for communicating and implementing safety information and polices. Department Heads and Directors report to Deans and are in charge of promoting safety and ensuring that safety polices are implemented and followed. Faculty/Principal Investigators (PIs) are held accountable for leading their individual laboratories and ensuring that safety polices are followed. Employees (e.g., staff) and students work within individual laboratories and report to their laboratory supervisor/manager (either another -- usually graduate or post doc -- student/employee supervisor or directly to the PI).

Table 3

Respondents' Demographic Characteristics

Demographics	M (*SD*)
Sex	338 men; 46.6%
Age (years)	30.89 (*SD* = 13.21)
Tenure (years)	3.52 (*SD* = 5.98)
Laboratory size (number of laboratory members)	10.21 (*SD* = 9.52)

The current study solicited participation from all PIs and the employees and/or students working in individual laboratories. A total of 969 individuals responded to the survey. Of those, 111 indicated that they were not laboratory personnel, 94 opened or clicked through the survey without responding, and 7 additional responses were removed as outliers for having responses that were at least five standard deviations from the mean (e.g., 40,578 injuries in the past 12 months). The final dataset of laboratory personnel included 757 responses. Demographic information is provided in Table 3. A majority of participants were Graduate Students (*n* = 229), followed by Undergraduate Students (*n* = 183), Research Scientists (*n* = 101), Post-Docs (*n* = 28), Lab Managers (*n* = 25), Principal Investigators (*n* = 23), and Research Associates (*n* = 22). Most respondents were personnel from biological laboratories (*n* = 219), followed by animal biological (*n* = 212), human subjects/office (*n* = 126), chemical (*n* = 124), mechanical/electrical (*n* = 65), and other (*n* = 11) laboratories. Those respondents from uncategorized laboratories specified that they work in nuclear physics, nuclear engineering, cereal grain, materials research, and hydropedology labs. The categorization of five laboratory types appears to be relatively inclusive considering only a small number of respondents were from uncategorized labs.

Procedure

This study utilized a within-subjects survey design via a web-based questionnaire using Qualtrics software. Laboratory personnel of all levels from undergraduate students to Principal Investigators (PI) were asked to complete a general safety climate measure and contextualized safety climate measure based on their corresponding laboratory type. This was determined based on their response to a skip logic question in which they indicated if they worked in an animal biological, biological, chemical, mechanical/electrical, human subject/office, or other laboratory. The general and contextualized measures were counterbalanced. Participants also completed measures of safety-related outcomes including safety knowledge, behavior, and incidents (i.e., injuries, incidents, and near-misses). All measures were completed at the individual-level because organizational constraints prohibited collecting identified data that would have allowed aggregation to the laboratory level.

In order to recruit participants, a bulk e-mail was sent to the distribution list of all faculty, staff, and students at Texas A&M University with an incentive to enter in a drawing to win one of five $100 VISA gift cards. The bulk e-mail was sent to over 65,000 subscribers. A recruitment email was also sent to faculty, staff, and students who completed online safety training in the last 2 years as well as individuals who are identified as Principal Investigators at the university. The survey was open between December 22, 2014 and February 1, 2015. One reminder message was sent on January 20, 2015.

Measures

General safety climate. Beus et al.'s (2013) safety climate measure was used as the general safety climate measure in this study. The measure consists of 30 items that are responded to on a 5-point Likert scale, ranging from strongly disagree to strongly agree. The items are subsumed under seven dimensions (i.e., management commitment to safety, safety communication, co-worker safety practices, safety training, safety involvement, safety rewards, and safety equipment & housekeeping). For the purposes of the current study, nine items from the 30-item measure were utilized (see Appendix A). Beus et al. (2013) developed an eight item short form from their 30-item measure; however, the nine items in the current study were identified based on two considerations: (1) a thorough analysis of the items and their conduciveness to alterations and (2) factor loadings of the 30-item measure from Beus et al. (2013). The nine-item measure includes one item for each dimension and two items from management commitment to safety and safety equipment & housekeeping. Slight alterations were made to general items to ensure that individuals respond according to their experiences in a laboratory and the behavior of their laboratory manager/PI. For example, items that referred to "my supervisor," and "my co-workers" were altered to "my laboratory manager/PI" and "my co-workers in the lab," respectively. These slight alterations are not considered to be contextualization, but rather common practice as they are meant only to ensure that individuals are thinking about a research laboratory (rather than industry). The coefficient alpha of the nine-item general measure in the current study was .95.

Contextualized safety climate. Six laboratory contextualized measures were developed: animal biological (Appendix B), biological (Appendix C), chemical Appendix D), mechanical/electrical (Appendix E), human subjects/office (Appendix F), and generic

(Appendix G). For each laboratory type, specific policies, practices and procedures, equipment, issues, and risks were identified. This information was gleaned from Furr's (2000) handbook of laboratory safety, laboratory safety research (Harper & Watt, 2012; National Research Council, 2014), and university manuals and inspection checklists (Michigan State University, 2014; The Ohio State University, 2014; Princeton University, 2014; Texas A&M University, 2009, 2012; Texas Tech University, n.d.; University of Texas at Austin, 2013; West Virginia University, 2012). Additional information was extracted from semi-structured interviews with a convenient sample of at least one PI and/or laboratory manager for each type of laboratory. The interviews consisted of questions concerning the general structure of individual laboratories, the associated risks and safety policies, practices, and procedures. Once the measures were developed, they were also reviewed by some of the PIs and their lab members for accuracy and completeness.

The nine general safety climate items from Beus et al. (2013) in Appendix A were modified for each contextualized measure. The items were initially identified based on their ambiguity and conduciveness to contextualization. For example, a management commitment item that was not chosen reads, "My supervisor is committed to improving safety." This item can involve a variety of potential practices that are not specific to a particular type of laboratory or work setting. The item, "My supervisor [laboratory manager/PI] strictly enforces the safe working procedures in my workgroup" was chosen because it is somewhat less ambiguous and allows for differentiation across laboratory type. How well the items loaded on their corresponding factor/dimension across two samples in Beus et al. (2013) was also considered.

Two additional items were chosen from the management commitment and safety equipment & housekeeping dimensions. An additional item was included from the management commitment dimension because of the importance of this dimension to safety climate. Two items from the equipment & housekeeping dimension were included because this dimension addresses two clearly distinct issues: equipment and housekeeping. Correspondingly, one item was chosen to represent each issue.

Items were contextualized to include safety cues relevant to each particular type of laboratory. Cues applicable to the particular domain and item follow each item. For example, the general item "equipment in my work area is checked to make sure it is free of faults" was altered in the animal biological laboratory measure to "Equipment in my lab is checked to make sure it is free of faults (a list of some of the equipment that is likely to be in your lab is provided below)." A list of equipment in order of applicability is then provided in bulleted form. Contextualized measures appear in Appendices B-G. The coefficient alphas for the six contextualized measures are as follows: animal biological (.90), biological (.89), chemical (.91), mechanical/electrical (.90), human subjects/office (.94), and generic (.82).

Self-report safety knowledge, behavior, and safety-related events. Participants completed Griffin and Neal's (2000) measures of safety knowledge, compliance, and participation (Appendix H). Each measure consists of four items responded to on a 5-point agreement scale. Coefficient alphas were .92, .93, and .89 respectively.

Respondents also provided individual safety incident data (Appendix H). Three items were used to assess the number of injuries, incidents, and near misses in the last 12 months.

Perceived job risk. Participants completed a measure of perceived job risk (Jermier Gaines, & McIntosh, 1989). The measure consists of three items that are responded to on a 5-

point Likert scale ranging from almost always untrue to almost always true (Appendix H). The coefficient alpha for the measure of perceived job risk in the current study was .87.

Analyses

Hypothesis testing. Both hypotheses were tested using an updated version of Steiger's Z for determining the significance of the difference between dependent correlations (Hoerger, 2013; Steiger, 1980). Hypothesis 1 stated that a contextualized safety climate measure has a stronger positive relationship with self-reported safety knowledge and behavior than a general safety climate measure. This hypothesis is supported if the correlations between a contextualized safety climate measure and safety knowledge, participation, and compliance are significantly greater than the relationships with a general safety climate measure. This hypothesis was tested for each of the contextualized safety climate measures except for the generic, uncategorized measure.

Hypothesis 2 stated that a contextualized safety climate measure has a stronger negative relationship with self-reported injuries, incidents, and near misses than a general safety climate measure. This hypothesis is supported if the correlations between a contextualized safety climate measure and injuries, incidents, and near misses are significantly greater than the relationships with a general safety climate measure. This hypothesis is tested for each of the contextualized safety climate measures except for the generic, uncategorized measure.

The current study also provides an initial analysis of the conduciveness of safety climate dimensions to contextualization (Research Question 1). The relationships between contextualized and general measures at the item-level and the various safety-related variables were also analyzed using Steiger's Z.

Additional analyses. Independent *t*-tests were used to test the significance of the difference in job-risk, injuries, incidents, and near misses between the five laboratory types. A Mann-Whitney test was also used to test the significance of the difference in the biosafety level of biological and animal biological respondents.

3. RESULTS

Testing for Order Effects

As noted earlier, the two safety climate measures were counterbalanced such that approximately half of the respondents (n = 387) received the general safety climate measure first followed by the contextualized safety climate measure and the other half of the respondents (n = 370) received the contextualized safety climate measure first followed by the general safety climate measure. An initial analysis was conducted to determine if the order in which the participants responded to the safety climate measures influenced the scores on these measures. A multivariate analysis of variance indicated that order did not have a significant effect on the contextualized safety climate scores, $F(1, 642) = .10$, $p = .75$, $\eta^2 < .001$, nor the general safety climate scores, $F(1, 642) = .01$, $p = .91$, $\eta^2 < .001$.

An additional analysis was conducted to more definitely determine if there were any order effects by examining the influence of order on the difference between the two safety climate assessments (Contextualized – General). An analysis of variance indicated that order did not have a significant effect on the difference between contextualized and general safety climate measures for animal biological, $F(1, 178) = .10$, $p = .75$, $\eta^2 = .001$, chemical, $F(1, 105) = .47$, $p = .49$, $\eta^2 = .004$, mechanical/electrical, $F(1, 54) = 1.51$, $p = .23$, $\eta^2 = .03$, and human subjects/office laboratory members, $F(1, 104) = 1.35$, $p = .25$, $\eta^2 = .01$. However, order did have a significant effect on the difference between safety climate measures for biological laboratory respondents, $F(1, 184) = 7.71$, $p = .006$, $\eta^2 = .04$. There was greater difference between measures when the general measure was completed first ($d = -.10$, $n = 93$) compared to the contextualized biological measure ($d = .04$, $n = 93$). Biology lab respondents tended to rate general safety climate higher than contextualized safety climate when they completed the general measure first compared to those who completed the contextualized biological measure first. It appears that reading contextualized items *after* general items led biological respondents to rate safety climate lower.

Comparisons with Previous Findings

General patterns of the relationships between variables in the current study are in in-line with previous meta-analytic results. Christian et al. (2009) meta-analyzed the relationship between safety climate and safety knowledge ($\rho = .24$). In the current study, the relationship between safety climate and knowledge was a bit stronger, ranging from .41 to .67. Christian et al. (2009) also analyzed the relationship between safety climate and safety behavior (participation: $\rho = .59$, compliance $\rho = .48$). Consistent with these values, the relationship in the current study between safety climate and participation ranged from .45 to .71; the relationship between safety climate and compliance ranged from .45 to .73. The correlation between accidents and injury rates and psychological safety climate ranged from -.14 to -.24 across three previous meta-analyses (Beus et al., 2010; Christian et al., 2009; Nahrgang et al., 2011). In the current study, the relationships between safety climate and each of the following: near misses, incidents, and injuries, ranged from -.01 to -.42.

Hypothesis Testing

Descriptive statistics and intercorrelations of all study variables for five of the contextualized measures are reported in Tables 4 through 8. Tables 9 and 10 and Figures 2 through 6 present the correlations between safety predictors and safety climate, facilitating a comparison of results obtained with contextualized and general safety climate measures. In Table 11 and Figures 7 and 8, results are presented aggregating across laboratory types.

Results for the generic safety climate measure are not provided because of a small sample size (n = 11). The generic measure was developed exclusively for those respondents who work in an uncategorized laboratory type.

Animal biological laboratory. The general and contextualized safety climate measures for animal biological laboratories were highly related (r = .80, n =180, p < .001). Hypothesis 1 was not supported for the animal biological measure. Although in the expected direction, the correlation between contextualized safety climate and safety knowledge (r = .44) and the correlation between general safety climate and knowledge were not significantly different (r = .41), Z(180) = .71, p = .48. The same was true for safety compliance (r = .47 vs. r = .45), Z(180) = .48, p = .63. The correlations with safety participation were opposite of the predicted direction, but not significantly different from one another (r = .45 vs. r = .51), Z(180) = -1.46, p = .14.

Hypothesis 2 was not supported for the animal biological measure. The contextualized and general safety climate correlations with near misses (r = -.22 vs. r = -.15), Z(180) = -1.50, p = .13, incidents (r = -.14 vs. r = -.10), Z(180) = -.85, p = .40, and injuries (r = -.20 vs. r = -.15), Z(180) = -1.07, p = .28, were not significantly different from one another, despite being in the expected direction.

Biological laboratory. The two safety climate measures were significantly related to one another for biological laboratories (r = .84, n = 186, p < .001). Contrary to the Hypothesis 1, the contextualized safety climate measure had a significantly weaker relationship with safety compliance compared to the general measure (r = .52 vs. r = .61), Z(186) = -2.68, p = .007. Relationships between the following safety variables and safety

Table 4

Animal Biological Laboratory Descriptive Statistics and Inter-correlations

Variable	*M*	*SD*	1	2	3	4	5	6	7	8	9	10
1. Safety knowledge	4.55	0.52	(.92)									
2. Safety participation	4.18	0.69	.63**	(.89)								
3. Safety compliance	4.47	0.59	.72**	.63**	(.93)							
4. Injuries	0.33	1.12	-.03	-.04	-.07	--						
5. Incidents	0.49	1.40	.01	.02	-.04	.24**	--					
6. Near misses	0.72	1.61	.02	-.03	-.17*	.09	.26**	--				
7. Contextualized safety climate	4.25	0.64	.44**	.45**	.47**	-.15*	-.14	-.22**	(.90)			
8. General safety climate	4.21	0.77	.41**	.51**	.45**	-.20**	-.10	-.15*	.80**	(.95)		
9. Management commitment (C)	4.28	0.74	.30**	.32**	.33**	-.13	-.11	-.14	.88**	.63**	(.82)	
10. Management commitment (G)	4.23	0.87	.36**	.47**	.38**	-.19**	-.14	-.14	.75**	.92**	.64**	(.93)
11. Communication (C)	4.31	0.81	.38**	.39**	.36**	-.09	-.13	-.17*	.79**	.59**	.66**	.56**
12. Communication (G)	4.26	0.95	.35**	.44**	.36**	-.17*	-.15	-.12	.67**	.86**	.54**	.80**
13. Training (C)	4.23	0.86	.35**	.32**	.34**	.00	-.02	.06	.71**	.52**	.58**	.47**
14. Training (G)	4.30	0.85	.37**	.41**	.36**	-.14	-.08	-.02	.64**	.83**	.45**	.75**
15. Co-worker safety practices (C)	4.21	0.92	.25**	.29**	.36**	-.15	-.22**	-.35**	.75**	.66**	.59**	.62**
16. Co-worker safety practices (G)	3.96	1.02	.23**	.31**	.39**	-.22**	-.15*	-.28**	.68**	.79**	.58**	.67**
17. Equipment & housekeeping (C)	4.37	0.66	.36**	.36**	.46**	-.05	-.05	-.25**	.79**	.67**	.60**	.62**
18. Equipment & housekeeping (G)	4.31	0.80	.39**	.46**	.46**	-.12	.06	-.16*	.67**	.86**	.48**	.69**
19. Involvement (C)	4.27	0.88	.40**	.34**	.34**	-.24**	-.10	-.17*	.82**	.68**	.67**	.62**
20. Involvement (G)	4.26	0.88	.42**	.52**	.38**	-.17*	-.08	-.05	.73**	.91**	.57**	.82**
21. Rewards (C)	3.93	1.00	.34**	.34**	.30**	-.20**	-.18*	-.16*	.71**	.61**	.55**	.53**
22. Rewards (G)	4.03	0.99	.37**	.40**	.33**	-.20**	-.12	-.12	.65**	.79**	.48**	.68**

Table 4 continued

Variable	***M***	**SD**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
23. Counterbalanced order[a]	1.55	0.50	.02	.01	-.10	-.01	-.06	.09	-.02	-.05	-.01	.00
24. Animal biosafety level	1.67	0.59	.16	.13	.12	-.01	-.10	.00	.07	.13	-.03	.08
25. Job risk	1.86	0.83	-.17*	-.06	-.27**	.19*	.07	.10	-.28**	-.26**	-.19*	-.19*
26. Position[b]	2.90	2.08	.16*	.23**	.11	.14	.10	.19*	-.05	.05	-.05	.06
27. Tenure (months)	45.07	78.91	.19*	.22**	.16*	.24**	.17*	.16	.11	.14	.07	.15
28. Number of lab members	11.32	11.05	.05	.12	.07	.10	.08	.34**	-.05	-.04	-.01	.01
29. Sex[c]	1.69	0.46	.03	.16*	.18*	.07	.08	.02	.04	.04	.07	.05
30. Age	30.17	13.20	.21**	.21**	.16*	.13	.21**	.12	.00	.06	-.04	.07

Table 4 continued

Variable	*M*	*SD*	11	12	13	14	15	16	17	18	19	20
11. Communication (C)	4.31	0.81	--									
12. Communication (G)	4.26	0.95	.61**	--								
13. Training (C)	4.23	0.86	.62**	.41**	--							
14. Training (G)	4.30	0.85	.47**	.63**	.54**	--						
15. Co-worker safety practices (C)	4.21	0.92	.49**	.55**	.28**	.48**	--					
16. Co-worker safety practices (G)	3.96	1.02	.38**	.57**	.37**	.58**	.65**	--				
17. Equipment & housekeeping (C)	4.37	0.66	.58**	.49**	.53**	.61**	.61**	.55**	(.75)			
18. Equipment & housekeeping (G)	4.31	0.80	.48**	.67**	.59**	.69**	.55**	.72**	.71**	(.85)		
19. Involvement (C)	4.27	0.88	.61**	.61**	.50**	.48**	.57**	.54**	.50**	.50**	--	
20. Involvement (G)	4.26	0.88	.57**	.80**	.42**	.75**	.59**	.63**	.54**	.71**	.68**	--
21. Rewards (C)	3.93	1.00	.46**	.49**	.39**	.41**	.49**	.54**	.37**	.42**	.66**	.61**
22. Rewards (G)	4.03	0.99	.48**	.69**	.30**	.57**	.47**	.55**	.42**	.57**	.65**	.78**
23. Counterbalanced order[a]	1.55	0.50	.09	.02	.00	-.12	-.03	-.16*	-.16*	-.11	.00	.01
24. Animal biosafety level	1.67	0.59	.09	.06	.16	.22*	-.02	.09	.18*	.16	.04	.07
25. Job risk	1.86	0.83	-.23**	-.20**	-.16*	-.24**	-.21**	-.30**	-.25**	-.24**	-.36**	-.20**
26. Position[b]	2.90	2.08	-.01	.08	.02	.12	-.11	-.13	.06	.07	-.12	.05
27. Tenure (months)	45.07	78.91	.13	.16*	.04	.10	.03	.03	.12	.12	.13	.17*
28. Number of lab members	11.32	11.05	-.09	.02	.06	.04	-.06	-.12	.06	-.03	-.10	-.03
29. Sex[c]	1.69	0.46	.08	.05	.07	.02	.02	.01	.05	.07	-.06	.03
30. Age	30.17	13.20	.00	.07	.01	.05	-.04	-.03	.04	.09	.03	.08

Table 4 continued

Variable	*M*	*SD*	21	22	23	24	25	26	27	28	29
21. Rewards (C)	3.93	1.00	--								
22. Rewards (G)	4.03	0.99	.69**	--							
23. Counterbalanced order[a]	1.55	0.50	.05	.06	--						
24. Animal biosafety level	1.67	0.59	.05	.10	-.01	--					
25. Job risk	1.86	0.83	-.25**	-.24**	.13	-.06	--				
26. Position[b]	2.90	2.08	-.09	-.01	-.05	.04	.09	--			
27. Tenure (months)	45.07	78.91	.10	.08	-.09	-.08	.02	.44**	--		
28. Number of lab members	11.32	11.05	-.20**	-.12	.07	.13	.17*	.19*	-.02	--	
29. Sex[d]	1.69	0.46	-.07	-.02	-.18*	-.07	-.04	.01	-.15	.06	--
30. Age	30.17	13.20	.00	.03	.00	.02	.03	.67**	.77**	.03	-.18*

Notes. *n* = 212; Reliabilities (coefficient alphas) appear on the diagonal except management commitment and equipment & housekeeping, which are two item correlations; C = contextualized safety climate, G = general safety climate; [a] 1 = contextualized-general, 2 = general-contextualized; [b] 1 = undergraduate student, 2 = graduate student, 3 = post-doc, 4 = lab manager, 5 = research scientist, 6 = research associate, 7 = principal investigator, 8 = other; [c] 1 = male, 2 = female; * *p* ≤ .05, ** p ≤ .01

climate were also opposite of expectations with general being stronger than contextual, but statistically equivalent: safety knowledge ($r = .41$ vs. $r = .47$), $Z(186) = -1.62$, $p = .11$, and participation ($r = .48$ vs. $r = .53$), $Z(186) = -1.41$, $p = .16$. Thus, Hypothesis 1 was not supported for the biological measure.

Hypothesis 2 was not supported for the biological measure, either. However, as predicted, the contextualized safety climate measure had a stronger relationship with near misses ($r = -.35$ vs. $r = -.28$), $Z(186) = -1.78$ $p = .08$. The relationship between contextualized and general safety climate and incidents ($r = -.21$ vs. $r = -.16$), $Z(186) = -1.22$, $p = .22$, and injuries ($r = -.28$ vs. $r = -.24$), $Z(186) = -.99$, $p = .32$, were also supportive of prediction, but statistically equivalent.

Chemical laboratory. For chemical laboratories, the contextualized and general safety climate measures were strongly related ($r = .86$, $n = 107$, $p < .001$). Contextualized and general safety climate correlations with safety knowledge were equivalent ($r = .52$ vs. $r = .52$), $Z(107) = .00$, $p = 1.0$. Correlations for participation and compliance were opposite of the hypothesized direction, but statistically equivalent ($r = .49$ vs. $r = .51$), $Z(107) = -.45$, $p = .65$, and ($r = .55$ vs. $r = .57$), $Z(107) = -.47$, $p = .64$, respectively. Thus, Hypothesis 1 was not supported for the chemical measure.

Contrary to expectation, the general safety climate measure was more strongly related to near misses ($r = -.33$) than the contextualized measure ($r = -.31$), $Z(107) = .41$, $p = .68$; however, the correlations were not significantly different. Although in the expected direction, correlations with incidents ($r = -.21$ vs. $r = -.17$), $Z(107) = -.79$, $p = .43$, and injuries ($r = -.21$ vs. $r = -.17$), $Z(107) = -.79$, $p = .43$ were equivalent. Hypothesis 2 was not supported for the chemical measure.

Table 5

Biological Laboratory Descriptive Statistics and Inter-correlations

Variable	***M***	***SD***	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1. Safety knowledge	4.51	0.58	(.93)									
2. Safety participation	4.15	0.67	.65**	(.89)								
3. Safety compliance	4.43	0.64	.74**	.66**	(.94)							
4. Injuries	0.18	0.67	-.09	-.06	-.18*	--						
5. Incidents	0.26	0.74	.07	-.04	-.10	.22**	--					
6. Near misses	0.58	1.53	-.03	-.14	-.29**	.18*	.36**	--				
7. Contextualized safety climate	4.27	0.57	.41**	.48**	.52**	-.28**	-.21**	-.35**	(.89)			
8. General safety climate	4.30	0.64	.47**	.53**	.61**	-.24**	-.16*	-.28**	.84**	(.93)		
9. Management commitment (C)	4.38	0.66	.31**	.38**	.46**	-.12	-.18*	-.31**	.81**	.74**	(.79)	
10. Management commitment (G)	4.37	0.73	.40**	.47**	.54**	-.18*	-.18*	-.30**	.75**	.90**	.76**	(.89)
11. Communication (C)	4.39	0.72	.34**	.40**	.38**	-.09	-.16*	-.21**	.75**	.63**	.64**	.54**
12. Communication (G)	4.41	0.73	.35**	.42**	.43**	-.14	-.11	-.19**	.62**	.83**	.61**	.70**
13. Training (C)	4.14	0.87	.37**	.36**	.33**	-.14	-.05	-.10	.69**	.59**	.47**	.48**
14. Training (G)	4.37	0.74	.46**	.43**	.50**	-.08	-.07	-.14*	.67**	.82**	.62**	.69**
15. Co-worker safety practices (C)	4.29	0.86	.23**	.26**	.32**	-.37**	-.21**	-.33**	.70**	.53**	.42**	.38**
16. Co-worker safety practices (G)	4.06	0.85	.33**	.33**	.46**	-.39**	-.21**	-.33**	.70**	.78**	.53**	.63**
17. Equipment & housekeeping (C)	4.39	0.66	.34**	.37**	.47**	-.39**	-.14	-.38**	.84**	.67**	.57**	.57**
18. Equipment & housekeeping (G)	4.36	0.68	.42**	.47**	.55**	-.35**	-.10	-.27**	.76**	.87**	.58**	.68**
19. Involvement (C)	4.34	0.70	.27**	.35**	.33**	-.08	-.14	-.19**	.76**	.66**	.61**	.63**
20. Involvement (G)	4.35	0.74	.41**	.45**	.51**	-.08	-.03	-.12	.65**	.82**	.64**	.77**
21. Rewards (C)	3.78	1.05	.31**	.44**	.36**	-.20**	-.21**	-.22**	.72**	.60**	.47**	.52**
22. Rewards (G)	4.05	0.96	.37**	.46**	.49**	-.11	-.20**	-.18*	.68**	.78**	.54**	.63**

Table 5 continued

Variable	*M*	SD	1	2	3	4	5	6	7	8	9	10
23. Counterbalanced order[a]	1.53	0.50	-.01	.08	.03	.09	-.06	.05	.01	.11	.09	.13
24. Biosafety level	1.62	0.51	.14	.19*	.09	.07	.13	.12	.09	.05	.08	.07
25. Job risk	1.60	0.71	-.10	-.08	-.18*	.26**	.22**	.19**	-.35**	-.31**	-.31**	-.32**
26. Position[b]	2.99	2.05	.04	.11	.03	-.16*	-.19*	-.02	.06	.09	.08	.07
27. Tenure (months)	51.54	83.37	.00	.08	-.07	-.04	-.11	-.02	.00	.05	.00	.03
28. Number of lab members	9.66	8.82	-.15*	-.08	-.11	.23**	-.04	.19*	-.08	-.10	-.06	-.04
29. Sex[c]	1.58	0.50	.03	.03	.16*	-.03	-.08	.02	-.01	-.02	-.01	-.05
30. Age	33.05	14.55	.03	.17*	.04	-.12	-.20**	-.04	.04	.09	.06	.08

Table 5 continued

Variable	*M*	*SD*	11	12	13	14	15	16	17	18	19	20
11. Communication (C)	4.39	0.72	--									
12. Communication (G)	4.41	0.73	.54**	--								
13. Training (C)	4.14	0.87	.53**	.44**	--							
14. Training (G)	4.37	0.74	.56**	.69**	.57**	--						
15. Co-worker safety practices (C)	4.29	0.86	.44**	.32**	.39**	.38**	--					
16. Co-worker safety practices (G)	4.06	0.85	.51**	.58**	.45**	.59**	.64**	--				
17. Equipment & housekeeping (C)	4.39	0.66	.52**	.42**	.49**	.50**	.66**	.64**	(.73)			
18. Equipment & housekeeping (G)	4.36	0.68	.50**	.65**	.54**	.67**	.58**	.70**	.75**	(.78)		
19. Involvement (C)	4.34	0.70	.55**	.59**	.49**	.49**	.36**	.43**	.52**	.50**	--	
20. Involvement (G)	4.35	0.74	.55**	.71**	.53**	.65**	.31**	.50**	.41**	.59**	.58**	--
21. Rewards (C)	3.78	1.05	.43**	.38**	.39**	.40**	.40**	.44**	.51**	.52**	.56**	.45**
22. Rewards (G)	4.05	0.96	.47**	.61**	.44**	.56**	.38**	.51**	.47**	.62**	.56**	.64**
23. Counterbalanced order[a]	1.53	0.50	.00	.15*	-.01	.09	-.07	-.02	-.07	.03	.01	.09
24. Biosafety level	1.62	0.51	.09	-.04	.08	.04	.00	-.01	.07	.04	.05	.07
25. Job risk	1.60	0.71	-.25**	-.26**	-.22**	-.20**	-.32**	-.33**	-.28**	-.26**	-.19**	-.23**
26. Position[b]	2.99	2.05	.05	.14	.12	.11	.08	.04	.02	.10	.09	.10
27. Tenure (months)	51.54	83.37	.00	.12	.01	.08	.04	.04	-.04	.03	.01	.01
28. Number of lab members	9.66	8.82	.01	-.10	-.01	-.04	-.12	-.19*	-.15*	-.13	-.02	-.01
29. Sex[c]	1.58	0.50	-.02	-.03	.10	.01	.06	-.02	-.04	.00	-.04	.06
30. Age	33.05	14.55	.03	.12	.06	.07	.06	.04	-.02	.08	.06	.11

Table 5 continued

Variable	*M*	*SD*	21	22	23	24	25	26	27	28	29
21. Rewards (C)	3.78	1.05	--								
22. Rewards (G)	4.05	0.96	.72**	--							
23. Counterbalanced order[a]	1.53	0.50	.05	.17*	--						
24. Biosafety level	1.62	0.51	.08	.08	-.02	--					
25. Job risk	1.60	0.71	-.22**	-.19**	.04	.03	(.82)				
26. Position[b]	2.99	2.05	-.07	-.04	-.02	-.07	-.04	--			
27. Tenure (months)	51.54	83.37	.03	-.03	.10	-.19*	-.05	.55**	--		
28. Number of lab members	9.66	8.82	-.02	-.05	-.11	.20*	.11	-.06	-.17*	--	
29. Sex[c]	1.58	0.50	-.04	-.02	-.01	.17*	.03	-.10	-.06	.06	--
30. Age	33.05	14.55	-.01	.01	.02	-.08	-.01	.82**	.68**	-.08	-.08

Notes. n = 219; Reliabilities (coefficient alphas) appear on the diagonal except management commitment and equipment & housekeeping, which are two item correlations; C = contextualized safety climate, G = general safety climate; [a] 1 = contextualized-general, 2 = general-contextualized; [b] 1 = undergraduate student, 2 = graduate student, 3 = post-doc, 4 = lab manager, 5 = research scientist, 6 = research associate, 7 = principal investigator, 8 = other; [c] 1 = male, 2 = female; * $p \leq .05$, ** $p \leq .01$

Table 6

Chemical Laboratory Descriptive Statistics and Inter-correlations

Variable	***M***	***SD***	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1. Safety knowledge	4.44	0.54	(.90)									
2. Safety participation	4.14	0.67	.51**	(.87)								
3. Safety compliance	4.29	0.63	.66**	.60**	(.91)							
4. Injuries	0.56	2.63	-.13	-.10	-.09	--						
5. Incidents	0.86	2.67	-.12	-.11	-.09	.77**	--					
6. Near misses	1.19	2.80	-.13	-.15	-.19	.57**	.67**	--				
7. Contextualized safety climate	4.10	0.69	.52**	.49**	.55**	-.21*	-.21*	-.31**	(.91)			
8. General safety climate	4.10	0.73	.52**	.51**	.57**	-.17	-.17	-.33**	.86**	(.92)		
9. Management commitment (C)	4.11	0.94	.43**	.38**	.49**	-.18	-.18	-.26**	.84**	.72**	(.86)	
10. Management commitment (G)	4.20	0.87	.47**	.47**	.54**	-.03	-.06	-.25**	.80**	.90**	.75**	(.90)
11. Communication (C)	4.27	0.77	.49**	.48**	.44**	-.22*	-.18	-.29**	.74**	.64**	.62**	.65**
12. Communication (G)	4.27	0.87	.56**	.53**	.47**	-.18	-.15	-.27**	.70**	.79**	.52**	.73**
13. Training (C)	4.06	0.91	.49**	.35**	.41**	-.14	-.21*	-.23*	.79**	.70**	.59**	.62**
14. Training (G)	4.03	0.96	.54**	.37**	.47**	-.17	-.21*	-.29**	.74**	.81**	.65**	.69**
15. Co-worker safety practices (C)	4.06	0.95	.31**	.25**	.34**	-.11	-.13	-.25*	.72**	.61**	.52**	.56**
16. Co-worker safety practices (G)	3.72	1.06	.29**	.32**	.42**	-.21*	-.17	-.24*	.56**	.71**	.52**	.57**
17. Equipment & housekeeping (C)	4.15	0.75	.42**	.36**	.40**	-.19	-.19	-.32**	.79**	.64**	.49**	.52**
18. Equipment & housekeeping (G)	4.11	0.76	.42**	.37**	.47**	-.16	-.15	-.36**	.74**	.87**	.57**	.68**
19. Involvement (C)	4.12	0.93	.43**	.48**	.49**	-.19	-.19	-.26**	.85**	.79**	.76**	.75**
20. Involvement (G)	4.20	0.94	.43**	.48**	.41**	-.15	-.18	-.26**	.67**	.78**	.53**	.62**
21. Rewards (C)	3.80	1.01	.30**	.40**	.38**	-.14	-.09	-.11	.67**	.63**	.44**	.54**
22. Rewards (G)	4.05	0.98	.25**	.37**	.41**	-.16	-.10	-.17	.61**	.75**	.44**	.64**

Table 6 continued

Variable	*M*	SD	1	2	3	4	5	6	7	8	9	10
23. Counterbalanced order[a]	1.47	0.50	.06	.09	.02	.13	.07	.18	.07	.11	.07	.14
24. Chemical safety level	1.94	0.97	.31	.23	.27	.25	.07	.43	-.29	-.10	-.47	.07
25. Job risk	1.99	0.94	-.06	.01	-.14	.07	.19*	.10	-.33**	-.27**	-.22*	-.27**
26. Position[b]	2.78	1.83	.20*	.36**	.20*	-.11	-.14	-.17	.20*	.21*	.06	.20*
27. Tenure (months)	43.00	68.20	.20*	.27**	.13	-.06	-.07	-.09	.09	.13	-.08	.13
28. Number of lab members	10.64	8.52	.00	-.18	.04	-.03	-.03	-.10	-.10	-.08	-.01	-.05
29. Sex[c]	1.44	0.50	.05	.07	.15	-.02	-.13	-.13	.00	.02	.04	.03
30. Age	30.97	12.95	.26**	.33**	.20*	-.09	-.12	-.11	.14	.17	-.05	.18

Table 6 continued

Variable	*M*	*SD*	11	12	13	14	15	16	17	18	19	20
11. Communication (C)	4.39	0.72	--									
12. Communication (G)	4.41	0.73	.72**	--								
13. Training (C)	4.14	0.87	.57**	.61**	--							
14. Training (G)	4.37	0.74	.53**	.62**	.67**	--						
15. Co-worker safety practices (C)	4.29	0.86	.40**	.40**	.51**	.60**	--					
16. Co-worker safety practices (G)	4.06	0.85	.28**	.28**	.38**	.56**	.51**	--				
17. Equipment & housekeeping (C)	4.39	0.66	.49**	.49**	.60**	.54**	.57**	.42**	(.75)			
18. Equipment & housekeeping (G)	4.36	0.68	.52**	.64**	.60**	.66**	.52**	.67**	.69**	(.72)		
19. Involvement (C)	4.34	0.70	.70**	.79**	.63**	.59**	.46**	.39**	.62**	.64**	--	
20. Involvement (G)	4.35	0.74	.50**	.64**	.65**	.65**	.40**	.43**	.51**	.62**	.67**	--
21. Rewards (C)	3.78	1.05	.38**	.43**	.44**	.49**	.41**	.44**	.48**	.47**	.56**	.44**
22. Rewards (G)	4.05	0.96	.41**	.60**	.39**	.46**	.41**	.46**	.38**	.55**	.64**	.58**
23. Counterbalanced order[a]	1.53	0.50	-.06	.15	.06	.09	-.07	-.09	.01	.04	.15	.14
24. Chemical safety level	1.94	0.97	-.14	-.13	-.16	-.19	-.32	-.27	.09	-.10	-.19	-.14
25. Job risk	1.60	0.71	-.21*	-.16	-.31**	-.18	-.21*	-.19*	-.33**	-.24*	-.33**	-.19*
26. Position[b]	2.99	2.05	.16	.23*	.10	.18	.11	.07	.23*	.17	.27**	.18
27. Tenure (months)	51.54	83.37	.09	.22*	.12	.07	.07	-.02	.09	.10	.11	.11
28. Number of lab members	9.66	8.82	.07	.01	-.02	-.02	-.16	-.12	-.12	-.03	-.12	-.12
29. Sex[c]	1.58	0.50	.04	-.08	-.11	-.03	.03	.13	-.05	.02	-.02	-.06
30. Age	33.05	14.55	.19	.23*	.12	.12	.13	.02	.11	.12	.15	.12

Table 6 continued

Variable	*M*	*SD*	21	22	23	24	25	26	27	28	29
21. Rewards (C)	3.78	1.05	--								
22. Rewards (G)	4.05	0.96	.74**	--							
23. Counterbalanced order[a]	1.53	0.50	.19	.20*	--						
24. Chemical safety level	1.94	0.97	-.14	.19	.10	--					
25. Job risk	1.60	0.71	-.23*	-.26**	-.10	-.05	(.86)				
26. Position[b]	2.99	2.05	.27**	.17	-.04	-.26	-.03	--			
27. Tenure (months)	51.54	83.37	.24*	.15	-.06	.03	.09	.50**	--		
28. Number of lab members	9.66	8.82	-.24*	-.14	-.13	.41	.00	-.10	-.13	--	
29. Sex[c]	1.58	0.50	.03	.04	.09	-.18	-.13	-.07	-.17	-.07	--
30. Age	33.05	14.55	.27**	.16	-.14	-.06	.02	.77**	.76**	-.14	-.20

Notes. n = 124; Reliabilities (coefficient alphas) appear on the diagonal except management commitment and equipment & housekeeping, which are two item correlations; C = contextualized safety climate, G = general safety climate; [a] 1 = contextualized-general, 2 = general-contextualized; [b] 1 = undergraduate student, 2 = graduate student, 3 = post-doc, 4 = lab manager, 5 = research scientist, 6 = research associate, 7 = principal investigator, 8 = other; [c] 1 = male, 2 = female; * $p \leq .05$, ** $p \leq .01$

Mechanical/electrical laboratory. The relationship between safety climate measures was strong for mechanical/electrical laboratories ($r = .70$, $n = 56$, $p < .001$). Contextualized and general safety climate measure correlations were the opposite of expectation, but statistically equivalent for the following variables: safety knowledge ($r = .64$ vs. $r = .67$), $Z(56) = -.40$, $p = .69$, participation ($r = .63$ vs. $r = .71$), $Z(56) = -1.09$, $p = .28$, and compliance ($r = .66$ vs. $r = .73$), $Z(56) = -.99$, $p = .32$. Therefore, Hypothesis 1 was not supported for the mechanical/electrical measure.

Hypothesis 2 was not supported for the mechanical/electrical measure, either. Contextualized and general safety climate correlations with near misses, incidents, and injuries were statistically equivalent: near misses ($r = -.12$ vs. $r = -.10$), $Z(56) = -.19$, $p = .85$, incidents ($r = -.08$ vs. $r = -.12$), $Z(56) = .38$, $p = .71$, and injuries ($r = -.01$ vs. $r = -.12$), $Z(56) = 1.04$, $p = .30$.

Human subjects/office laboratory. Results for human subjects/office laboratories indicated that the safety climate measures were significantly related ($r = .66$, $n = 106$, $p < .001$); however, this relationship was the weakest of the five laboratory types. Hypothesis 1 was partially supported for the human subjects/office measure. Compared to the general safety climate measure, the contextualized safety climate measure had a significantly stronger relationship with safety knowledge ($r = .62$ vs. $r = .43$), $Z(106) = 2.89$, $p = .004$. Correlation comparisons with safety participation ($r = .59$ vs. $r = .47$), $Z(106) = 1.82$, $p = .07$, and compliance ($r = .64$ vs. $r = .53$), $Z(106) = 1.76$, $p = .08$ were in the expected direction, but not statistically different.

Table 7

Mechanical/Electrical Laboratory Descriptive Statistics and Inter-correlations

Variable	***M***	***SD***	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1. Safety knowledge	4.31	0.58	(.93)									
2. Safety participation	4.14	0.62	.66**	(.89)								
3. Safety compliance	4.24	0.58	.89**	.64**	(.92)							
4. Injuries	0.38	0.97	-.08	.06	-.05	--						
5. Incidents	0.91	3.48	-.06	-.03	-.03	.19	--					
6. Near misses	0.78	1.80	.06	.12	.02	.44**	.19	--				
7. Contextualized safety climate	4.11	0.57	.64**	.63**	.66**	-.01	-.08	-.12	(.90)			
8. General safety climate	4.06	0.67	.67**	.71**	.73**	-.12	-.12	-.10	.70**	(.95)		
9. Management commitment (C)	4.24	0.74	.53**	.47**	.52**	.02	.05	-.12	.88**	.62**	(.84)	
10. Management commitment (G)	4.17	0.74	.66**	.61**	.69**	-.07	-.01	.01	.61**	.91**	.55**	(.94)
11. Communication (C)	4.12	0.77	.39**	.38**	.45**	.00	-.02	-.13	.81**	.57**	.82**	.52**
12. Communication (G)	4.04	0.83	.46**	.68**	.53**	-.04	-.08	-.07	.53**	.85**	.50**	.76**
13. Training (C)	4.02	0.71	.49**	.45**	.50**	.06	-.04	-.06	.71**	.43**	.54**	.33*
14. Training (G)	4.02	0.82	.57**	.51**	.63**	-.14	-.09	-.19	.56**	.82**	.50**	.68**
15. Co-worker safety practices (C)	4.07	0.78	.24	.50**	.31*	.13	-.12	-.03	.63**	.36**	.43**	.32*
16. Co-worker safety practices (G)	3.86	0.84	.50**	.57**	.58**	-.22	-.30*	-.20	.56**	.85**	.42**	.76**
17. Equipment & housekeeping (C)	4.22	0.60	.62**	.55**	.62**	-.11	-.13	-.22	.86**	.58**	.69**	.46**
18. Equipment & housekeeping (G)	4.09	0.67	.64**	.68**	.73**	-.05	-.08	-.10	.70**	.91**	.64**	.77**
19. Involvement (C)	4.04	0.78	.63**	.66**	.63**	.03	-.14	.06	.82**	.69**	.63**	.62**
20. Involvement (G)	4.02	0.84	.45**	.59**	.52**	-.16	.03	-.16	.62**	.85**	.59**	.71**
21. Rewards (C)	3.95	0.81	.56**	.51**	.58**	-.13	-.11	-.11	.68**	.60**	.44**	.52**
22. Rewards (G)	4.07	0.83	.62**	.61**	.57**	-.08	-.28*	.05	.60**	.77**	.45**	.68**

Table 7 continued

Variable	*M*	SD	1	2	3	4	5	6	7	8	9	10
23. Counterbalanced order[a]	1.51	0.50	-.23	-.03	-.23	.29*	-.05	.26*	.00	-.13	.01	-.09
24. Job risk	1.82	0.90	-.04	.23	-.14	.26	.09	.23	.02	-.03	.05	-.02
25. Position[b]	2.76	1.83	.01	.05	-.04	-.13	.31*	.04	-.10	-.19	-.05	-.20
26. Tenure (months)	29.98	39.37	.21	.13	.13	-.08	.00	.08	.07	.07	.01	.08
27. Number of lab members	9.31	6.52	.15	.19	.28*	.05	.00	.19	.18	.26	.07	.30*
28. Sex[c]	1.20	0.41	-.11	-.07	-.08	.12	.42**	.02	-.18	-.24	-.19	-.21
29. Age	30.35	12.89	.17	.15	.07	-.16	-.06	.07	.00	.03	-.04	.04

Table 7 continued

Variable	*M*	*SD*	11	12	13	14	15	16	17	18	19	20
11. Communication (C)	4.12	0.77	--									
12. Communication (G)	4.04	0.83	.51**	--								
13. Training (C)	4.02	0.71	.47**	.35**	--							
14. Training (G)	4.02	0.82	.43**	.77**	.48**	--						
15. Co-worker safety practices (C)	4.07	0.78	.37**	.20	.39**	.11	--					
16. Co-worker safety practices (G)	3.86	0.84	.37**	.66**	.29*	.69**	.43**	--				
17. Equipment & housekeeping (C)	4.22	0.60	.55**	.37**	.55**	.53**	.50**	.49**	(.70)			
18. Equipment & housekeeping (G)	4.09	0.67	.54**	.71**	.41**	.72**	.39**	.73**	.61**	(.74)		
19. Involvement (C)	4.04	0.78	.71**	.61**	.56**	.55**	.45**	.52**	.65**	.62**	--	
20. Involvement (G)	4.02	0.84	.56**	.68**	.38**	.63**	.28*	.60**	.51**	.80**	.57**	--
21. Rewards (C)	3.95	0.81	.41**	.38**	.41**	.44**	.39**	.60**	.55**	.57**	.54**	.48**
22. Rewards (G)	4.07	0.83	.45**	.53**	.38**	.48**	.37**	.67**	.47**	.64**	.64**	.65**
23. Counterbalanced order[a]	1.51	0.50	-.02	-.13	-.02	-.20	.09	-.12	-.19	-.11	.00	-.15
24. Job risk	1.82	0.90	.12	.13	.02	-.14	.14	-.18	-.12	.02	.08	-.01
25. Position[b]	2.76	1.83	-.07	-.14	.12	-.07	-.08	-.21	-.05	-.15	-.19	-.09
26. Tenure (months)	29.98	39.37	.01	.01	.20	.13	.10	.09	.05	.03	.04	.03
27. Number of lab members	9.31	6.52	.14	.24	.22	.24	.06	.24	.11	.15	.30*	.19
28 Sex[c]	1.20	0.41	-.20	-.20	-.17	-.18	-.13	-.26	-.02	-.21	-.22	-.06
29. Age	30.35	12.89	-.07	.02	.19	.03	.10	.09	.07	-.01	-.06	.01

Table 7 continued

Variable	*M*	*SD*	21	22	23	24	25	26	27	28
21. Rewards (C)	3.95	0.81	--							
22. Rewards (G)	4.07	0.83	.64**	--						
23. Counterbalanced order[a]	1.51	0.50	.15	.00	--					
24. Job risk	1.82	0.90	-.13	-.03	.10	(.87)				
25. Position[b]	2.76	1.83	-.25	-.26	-.13	.13	--			
26. Tenure (months)	29.98	39.37	.03	.08	-.21	.23	.44**	--		
27. Number of lab members	9.31	6.52	.18	.24	.14	-.16	-.13	-.18	--	
28. Sex[c]	1.20	0.41	-.12	-.33*	-.14	.10	.08	-.06	-.07	--
29. Age	30.35	12.89	-.17	.00	-.24	.15	.71**	.70**	-.14	-.12

Notes. n = 65; Reliabilities (coefficient alphas) appear on the diagonal except management commitment and equipment & housekeeping, which are two item correlations; C = contextualized safety climate, G = general safety climate; [a] 1 = contextualized-general, 2 = general-contextualized; [b] 1 = undergraduate student, 2 = graduate student, 3 = post-doc, 4 = lab manager, 5 = research scientist, 6 = research associate, 7 = principal investigator, 8 = other; [c] 1 = male, 2 = female; * $p \leq .05$, ** $p \leq .01$

Hypothesis 2 was partially supported for the human subjects/office measure. Whereas the difference in the correlations between contextualized and general safety climate with incidents (*r* = -.42 vs. *r* = -.29), *Z*(106) = -1.74, *p* = .08 and with near misses was not statistically significant (*r* = -.36, vs. *r* = -.24), *Z*(106) = -1.57, *p* = .12, the difference between the correlations was significant for injuries (*r* = -.34 vs. *r* = -.13), *Z*(106) = -2.70, *p* = .007.

Overall results and aggregated comparisons. When the data are aggregated across contextualized measures (see Table 11 and Figure 7), the contextualized measure consistently outperforms the general measure as the magnitude of the correlation is always higher (albeit sometimes only slightly) for the contextualized measure. Comparisons of the correlations with six predictors as related to contextualized and general safety climate across laboratory types are as follows: safety knowledge (.52 vs. .46), participation (.51 vs. .50), and compliance (.54 vs. .53), and near misses (-.25 vs. -.21), incidents (-.14 vs. -.12), and injuries (-.17 vs. -.15). Nevertheless, the only difference that meets statistical significance ($p < .05$) is the one between the relationships with safety knowledge.

When the data are parsed by laboratory, the pattern of correlations for the human subjects/office laboratory almost perfectly mimic the results for the aggregated data (see Table 11 and Figure 6). Compared to the general measure of safety climate, the human subjects/office laboratory measure was the only contextualized measure consistently more strongly related to multiple safety predictors: safety knowledge (.62 vs. .43), participation (.59 vs. .47), and compliance (.64 vs. .53), near misses (-.36 vs. -.24), incidents (-.42 vs. -.29), and injuries (-.34 vs. -13). These differences are statistically meaningful for safety knowledge and injuries. The only

Table 8

Human Subjects/Office Laboratory Descriptive Statistics and Inter-correlations

Variable	*M*	*SD*	1	2	3	4	5	6	7	8	9	10
1. Safety knowledge	4.34	0.70	(.94)									
2. Safety participation	3.93	0.74	.66**	(.90)								
3. Safety compliance	4.41	0.68	.84**	.59**	(.95)							
4. Injuries	0.15	0.66	-.13	-.10	-.20*	--						
5. Incidents	0.10	0.43	-.18	-.11	-.26**	.65**	--					
6. Near misses	0.27	0.84	-.11	-.03	-.14	.38**	.48**	--				
7. Contextualized safety climate	4.02	0.81	.62**	.59**	.64**	-.34**	-.42**	-.36**	(.94)			
8. General safety climate	3.96	0.94	.43**	.47**	.53**	-.13	-.29**	-.24*	.66**	(.97)		
9. Management commitment (C)	4.10	0.94	.51**	.48**	.52**	-.21*	-.33**	-.30**	.88**	.59**	(.86)	
10. Management commitment (G)	3.96	1.02	.42**	.49**	.52**	-.14	-.28**	-.15	.61**	.95**	.56**	(.96)
11. Communication (C)	4.01	1.03	.52**	.57**	.51**	-.21*	-.23*	-.17	.81**	.54**	.77**	.51**
12. Communication (G)	3.92	1.17	.36**	.46**	.42**	-.04	-.22*	-.24*	.65**	.91**	.59**	.87**
13. Training (C)	3.79	1.08	.45**	.49**	.54**	-.23*	-.28**	-.26**	.76**	.45**	.62**	.41**
14. Training (G)	4.03	1.08	.41**	.42**	.53**	-.06	-.23*	-.22*	.62**	.92**	.56**	.83**
15. Co-worker safety practices (C)	3.99	0.91	.55**	.50**	.51**	-.35**	-.37**	-.47**	.79**	.52**	.57**	.43**
16. Co-worker safety practices (G)	3.96	1.00	.33**	.28**	.43**	-.17	-.27**	-.41**	.54**	.84**	.48**	.75**
17. Equipment & housekeeping (C)	4.10	0.85	.52**	.45**	.54**	-.44**	-.48**	-.35**	.84**	.51**	.59**	.46**
18. Equipment & housekeeping (G)	4.03	0.93	.38**	.40**	.52**	-.17	-.35**	-.24*	.54**	.91**	.45**	.80**
19. Involvement (C)	3.99	1.04	.61**	.49**	.57**	-.30**	-.39**	-.28**	.90**	.66**	.76**	.60**
20. Involvement (G)	3.93	1.06	.42**	.46**	.48**	-.14	-.25*	-.22*	.65**	.94**	.59**	.87**
21. Rewards (C)	3.89	1.07	.55**	.62**	.58**	-.21*	-.34**	-.25**	.87**	.64**	.74**	.62**
22. Rewards (G)	3.84	1.03	.39**	.50**	.46**	-.10	-.19*	-.13	.66**	.91**	.59**	.86**

Table 8 continued

Variable	*M*	SD	1	2	3	4	5	6	7	8	9	10
23. Counterbalanced order[a]	1.48	0.50	.05	.01	.11	-.12	-.02	-.03	.00	-.06	-.01	.01
24. Job risk	1.16	0.45	-.09	-.09	-.18	.53**	.52**	.39**	-.23*	-.22*	-.18	-.18
25. Position[b]	2.48	1.73	-.17	-.14	-.12	-.06	.02	.10	-.10	.01	-.03	.05
26. Tenure (months)	25.74	43.30	.01	.08	.01	-.10	-.08	.05	.08	.10	.09	.11
27. Number of lab members	9.61	10.39	-.02	.08	.04	-.03	-.12	-.11	.07	.03	.11	.02
28. Sex[c]	1.48	0.50	-.05	.07	-.03	-.01	-.13	.12	-.06	.12	-.10	.11
29. Age	28.65	10.85	.09	.08	.08	-.04	.07	.06	.02	.01	.05	.04

Table 8 continued

Variable	*M*	*SD*	11	12	13	14	15	16	17	18	19	20
11. Communication (C)	4.01	1.03	--									
12. Communication (G)	3.92	1.17	.58**	--								
13. Training (C)	3.79	1.08	.56**	.48**	--							
14. Training (G)	4.03	1.08	.51**	.88**	.51**	--						
15. Co-worker safety practices (C)	3.99	0.91	.53**	.49**	.53**	.49**	--					
16. Co-worker safety practices (G)	3.96	1.00	.36**	.68**	.27**	.71**	.51**	--				
17. Equipment & housekeeping (C)	4.10	0.85	.56**	.43**	.57**	.45**	.71**	.49**	(.76)			
18. Equipment & housekeeping (G)	4.03	0.93	.40**	.73**	.37**	.83**	.46**	.80**	.48**	(.83)		
19. Involvement (C)	3.99	1.04	.68**	.64**	.59**	.61**	.72**	.56**	.75**	.55**	--	
20. Involvement (G)	3.93	1.06	.53**	.85**	.44**	.84**	.52**	.75**	.50**	.83**	.68**	--
21. Rewards (C)	3.89	1.07	.66**	.64**	.63**	.57**	.64**	.51**	.67**	.49**	.79**	.61**
22. Rewards (G)	3.84	1.03	.59**	.83**	.44**	.79**	.47**	.72**	.47**	.76**	.65**	.84**
23. Counterbalanced order[a]	1.48	0.50	.04	-.07	.05	-.03	-.01	-.08	.01	-.09	-.06	-.07
24. Job risk	1.16	0.45	-.06	-.18	-.23*	-.18	-.27**	-.23*	-.23*	-.23*	-.23*	-.24*
25. Position[b]	2.48	1.73	-.03	-.01	-.08	.00	-.25**	-.02	-.05	.01	-.09	.03
26. Tenure (months)	25.74	43.30	.10	.06	.00	.11	.03	.05	.11	.10	.10	.10
27. Number of lab members	9.61	10.39	.05	.04	.00	.00	.06	.09	.07	.05	.03	.01
28. Sex[c]	1.48	0.50	.00	.16	-.18	.08	.01	.05	-.02	.12	-.02	.09
29. Age	28.65	10.85	.07	-.02	-.01	-.01	-.09	.00	.04	.01	.03	.04

Table 8 continued

Variable	*M*	*SD*	21	22	23	24	25	26	27	28
21. Rewards (C)	3.89	1.07	--							
22. Rewards (G)	3.84	1.03	.69**	--						
23. Counterbalanced order[a]	1.48	0.50	.05	-.08	--					
24. Job risk	1.16	0.45	-.16	-.13	.01	(.88)				
25. Position[b]	2.48	1.73	-.12	-.07	.03	.05	--			
26. Tenure (months)	25.74	43.30	.02	.10	-.06	-.05	.49**	--		
27. Number of lab members	9.61	10.39	.07	-.01	-.18	.07	-.04	-.13	--	
28. Sex[c]	1.48	0.50	-.04	.11	.00	-.10	-.09	-.02	.00	--
29. Age	28.65	10.85	-.04	-.01	-.02	.02	.71**	.76**	-.04	-.16

Notes. $n = 126$; Reliabilities (coefficient alphas) appear on the diagonal except management commitment and equipment & housekeeping, which are two item correlations; C = contextualized safety climate, G = general safety climate; [a] 1 = contextualized-general, 2 = general-contextualized; [b] 1 = undergraduate student, 2 = graduate student, 3 = post-doc, 4 = lab manager, 5 = research scientist, 6 = research associate, 7 = principal investigator, 8 = other; [c] 1 = male, 2 = female; * $p \leq .05$, ** $p \leq .01$

other significant difference was between the contextualized biological and general measure in their relationship with compliance. This relationship, however, was not in the expected direction.

Item-Level Analyses

This study also incorporates an exploratory assessment of seven safety climate dimensions. The dimensions which were theorized to benefit most from contextualization are safety equipment & housekeeping, co-worker safety practices, and safety training. These analyses are exploratory because only one or two items were included for each dimension. Tables 12 through 18 present correlations for each dimension by safety outcome and laboratory type. In the following discussion, only the correlations that were significantly different are reported; the majority of the relationships within each of the seven dimensions were statistically equivalent.

Management commitment to safety (item 1). Significant differences in the correlations with knowledge and behavior were opposite of expectations for the first management commitment item. The first item was less strongly related with safety knowledge when contextualized for mechanical/electrical laboratories ($r = .39$ vs. $r = .64$), $Z(54) = -2.20$, $p = .03$. The general management commitment item was also more strongly related with safety participation compared to the corresponding contextualized animal biological item ($r = .31$ vs. $r = .45$), $Z(178) = -2.38$, $p = .02$ and biological laboratory item ($r = .35$ vs. $r = .46$), $Z(185) = -2.07$, $p = .04$. The general item had a stronger relationship than the contextualized item with safety compliance for biological ($r = .38$ vs. $r = .54$), $Z(185) = -3.14$, $p = .002$ and mechanical/electrical laboratories ($r = .39$ vs. $r = .71$), $Z(54) = -3.16$, $p = .002$.

Table 9

Correlations between Safety Climate and Safety Knowledge and Safety Behavior by Laboratory

Laboratory type	**Contextualized vs. general**	**Knowledge**	**Participation**	**Compliance**
Animal biological	Contextualized	.44	.45	.47
	General	.41	.51	.45
Biological	Contextualized	.41	.48	.52[a]
	General	.47	.53	.61[a]
Chemical	Contextualized	.52	.49	.55
	General	.52	.51	.57
Mechanical/electrical	Contextualized	.64	.63	.66
	General	.67	.71	.73
Human subjects/office	Contextualized	.62[a]	.59	.64
	General	.43[a]	.47	.53

Note. [a] $p < .05$

Table 10

Correlations between Safety Climate and Injuries, Incidents, and Near Misses by Laboratory

Laboratory type	Contextualized vs. general	Injuries	Incidents	Near misses
Animal biological	Contextualized	-.15	-.14	-.22
	General	-.20	-.10	-.15
Biological	Contextualized	-.28	-.21	-.35
	General	-.24	-.16	-.28
Chemical	Contextualized	-.21	-.21	-.31
	General	-.17	-.17	-.33
Mechanical/electrical	Contextualized	-.01	-.08	-.12
	General	-.12	-.12	-.10
Human subjects/office	Contextualized	-.34[a]	-.42	-.36
	General	-.13[a]	-.29	-.24

Note. [a] $p < .05$

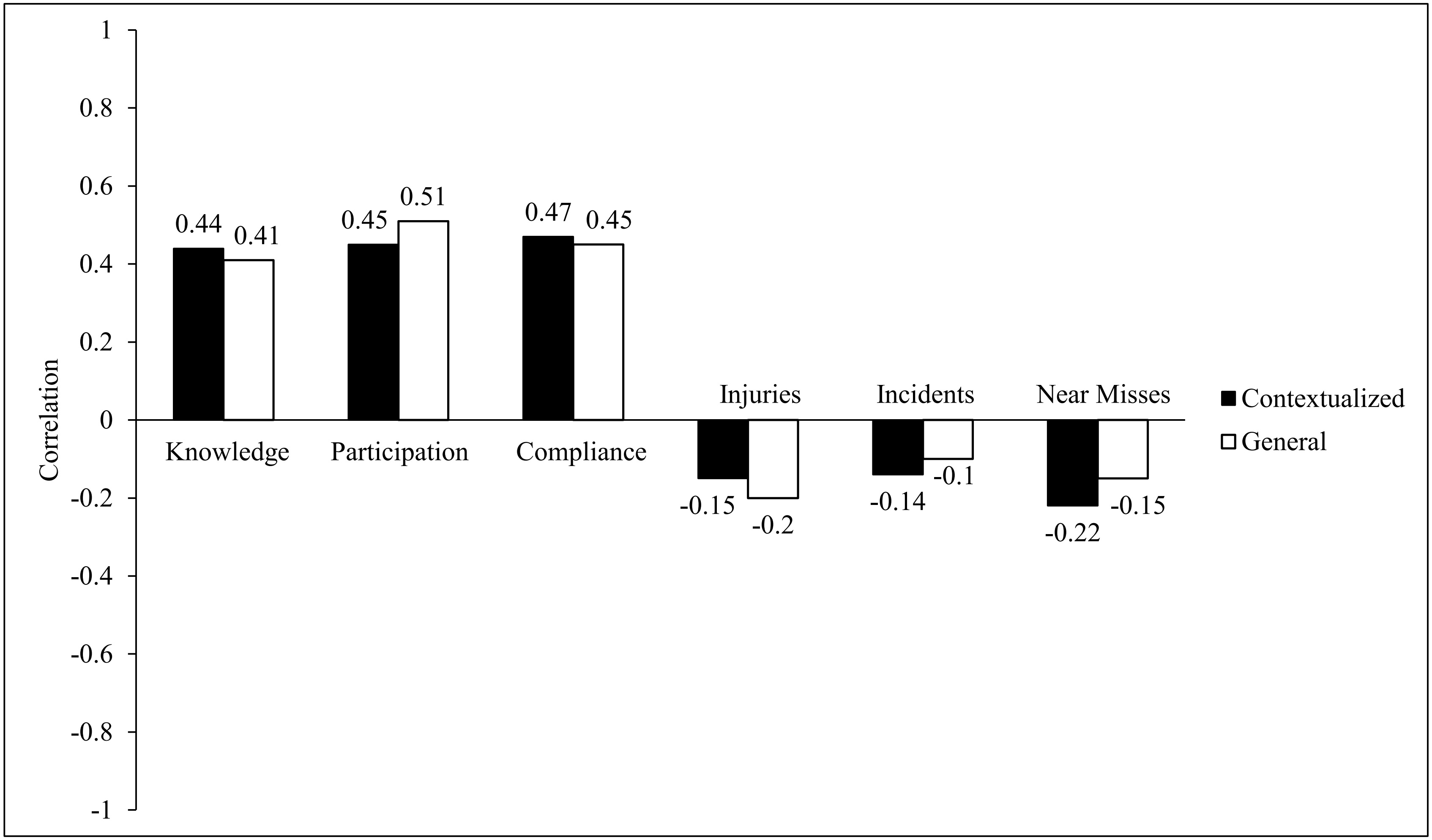

Figure 2. Safety climate correlations for animal biological laboratories. $n = 212$. * $p < .05$.

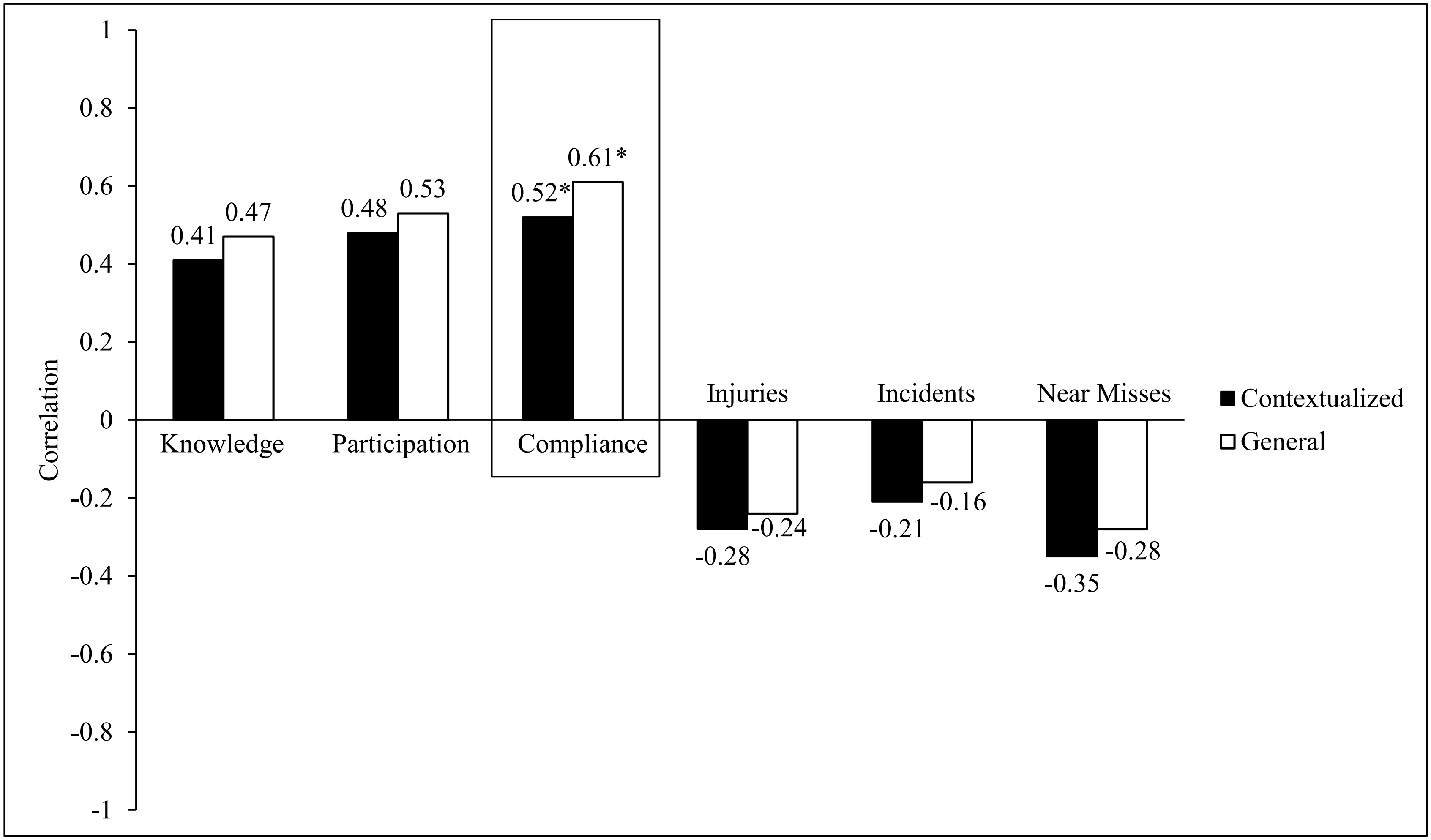

Figure 3. Safety climate correlations for biological laboratories. $n = 219$. * $p < .05$.

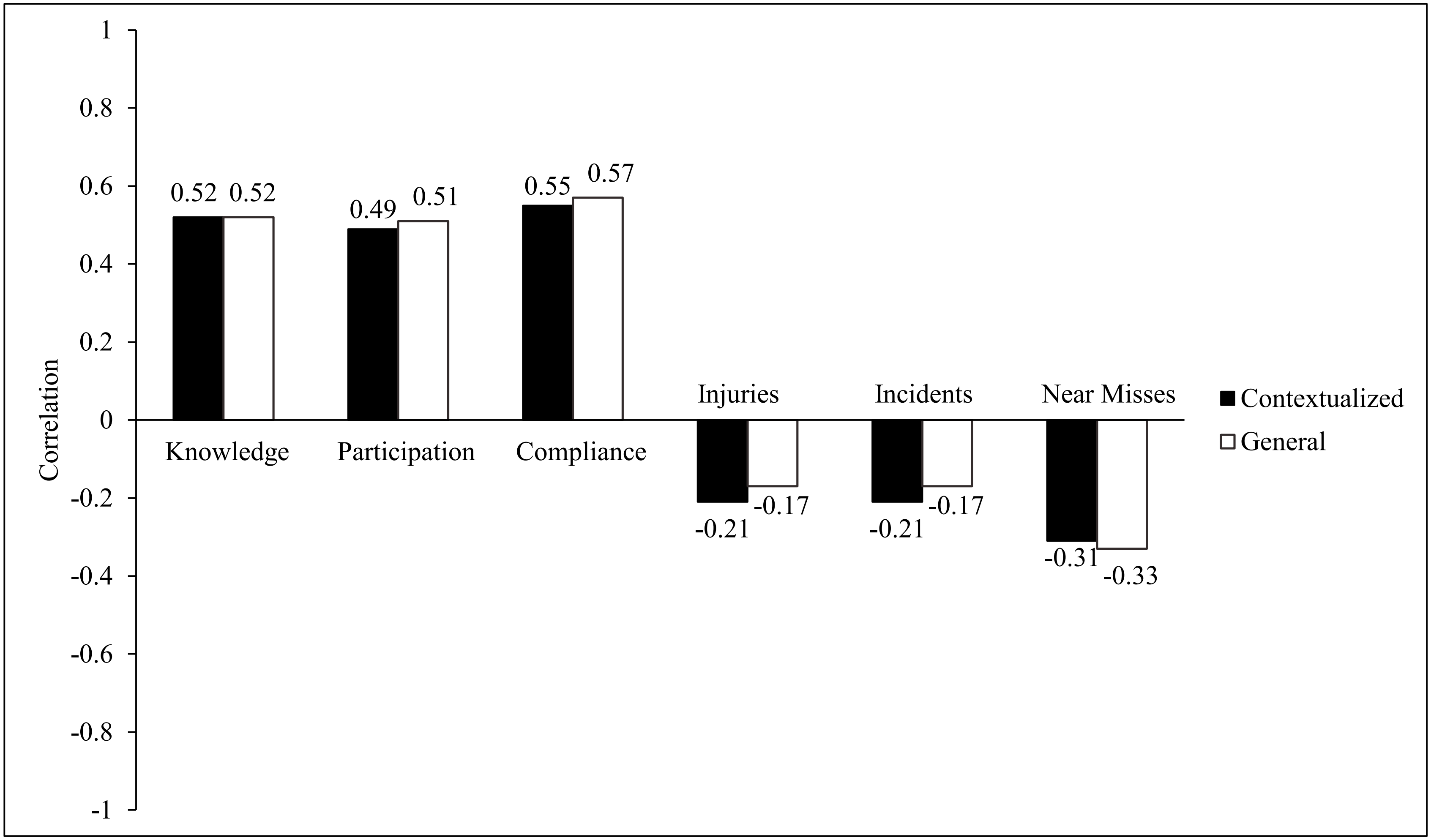

Figure 4. Safety climate correlations for chemical laboratories. n = 124. * p < .05.

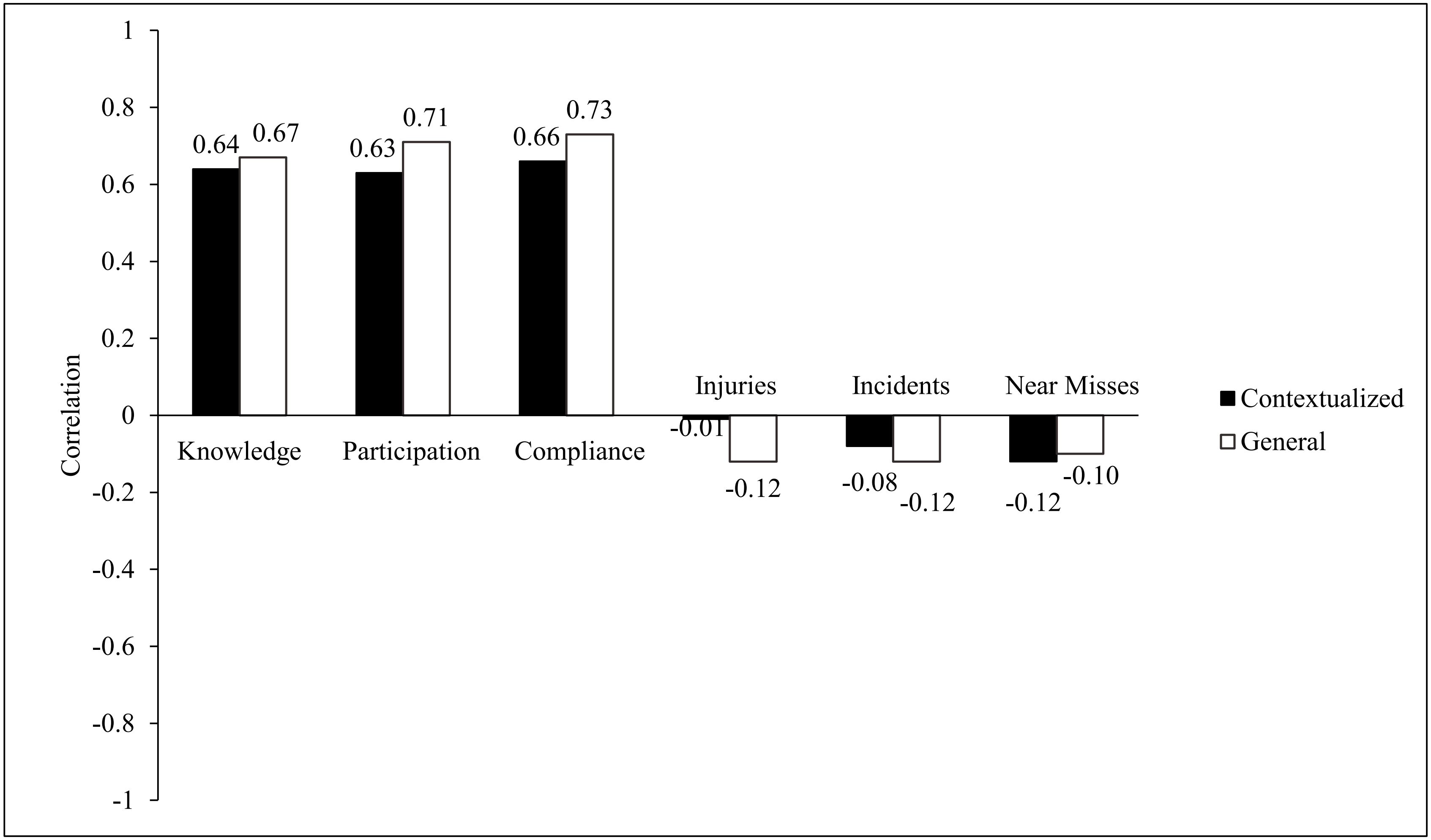

Figure 5. Safety climate correlations for mechanical/electrical laboratories. $n = 65$. * $p < .05$.

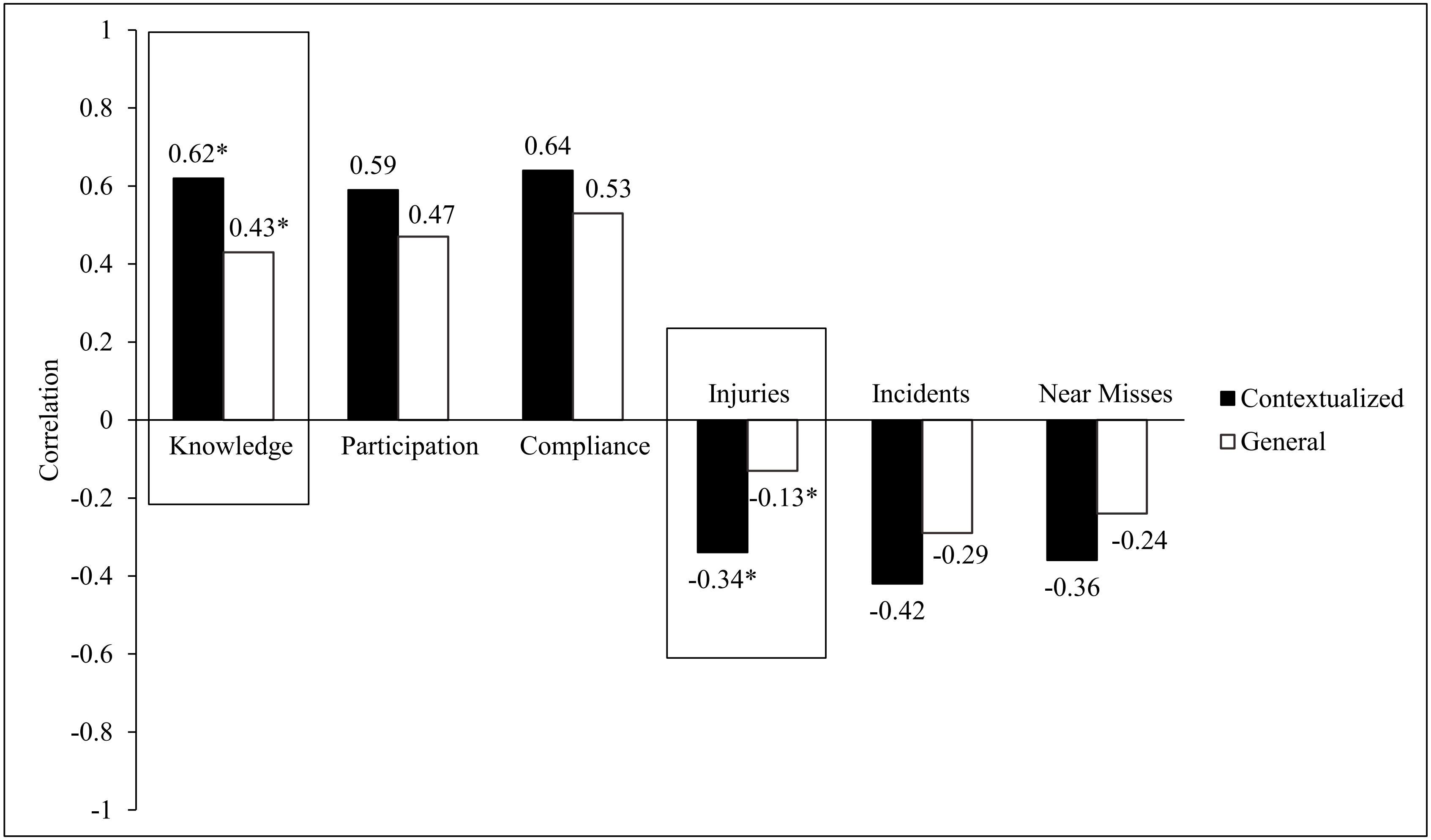

Figure 6. Safety climate correlations for human subjects/office laboratories. *n* = 126. * p < .05.

Table 11

Correlations between Safety Climate Measures and the Five Safety Predictors

Laboratory type	Contextualized vs. general	Knowledge	Participation	Compliance	Injuries	Incidents	Near Misses
Animal biological, biological, chemical, mechanical/electrical, human subjects/office (*n* = 644)	Contextualized	.52[a]	.51	.54	-.17	-.14	-.25
	General	.46[a]	.50	.53	-.15	-.12	-.21
Animal biological, biological, chemical, mechanical/electrical (*n* = 529)	Contextualized	.47	.48[a]	.52	-.18	-.16	-.28
	General	.48	.53[a]	.55	-.18	-.14	-.24
Human subjects/office (*n* = 106)	Contextualized	.62[a]	.59	.64	-.34[a]	-.42	-.36
	General	.43[a]	.47	.53	-.13[a]	-.29	-.24

Note. [a] $p < .05$

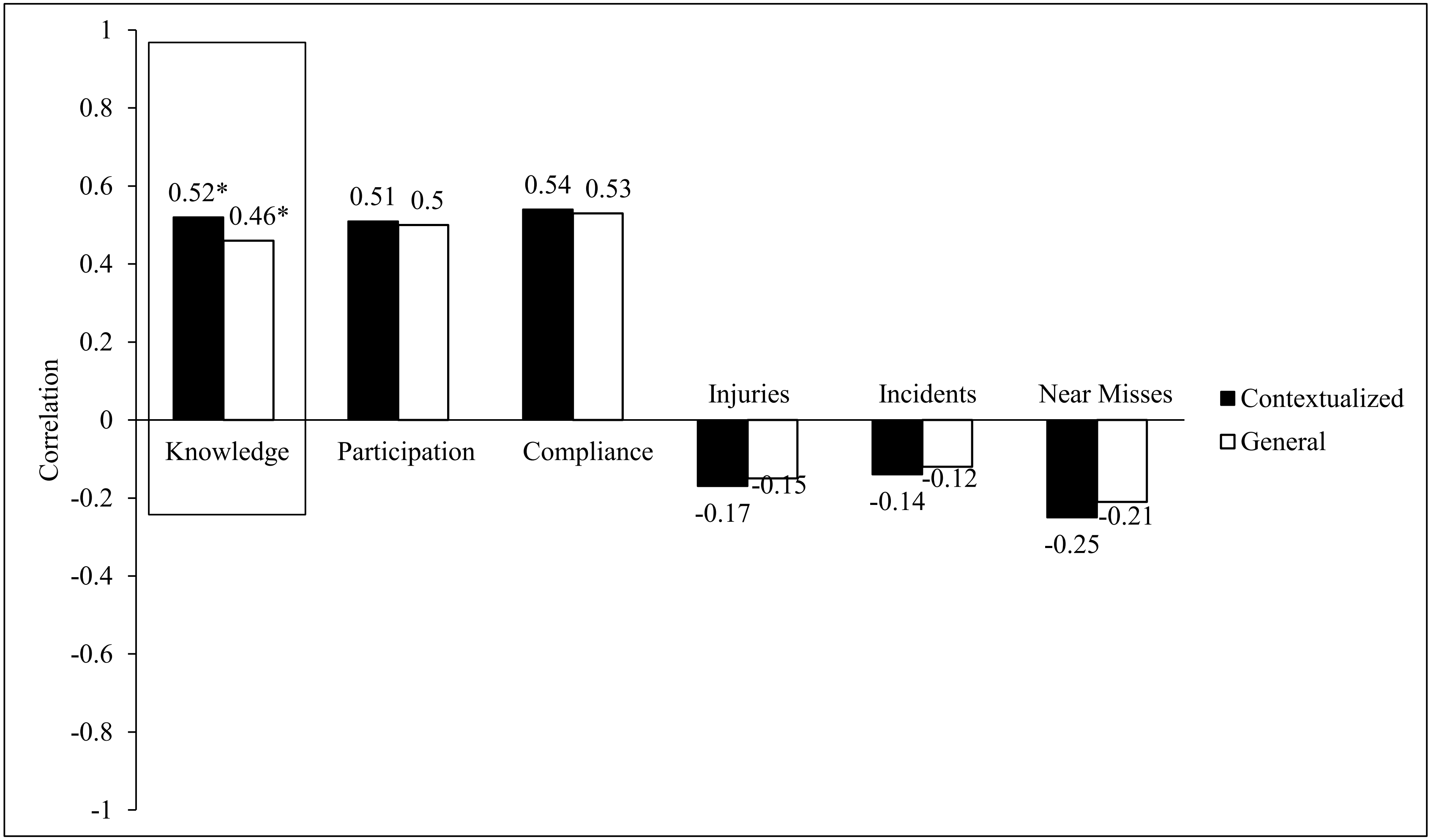

Figure 7. Safety climate correlations for all laboratory types. n = 644. * p < .05.

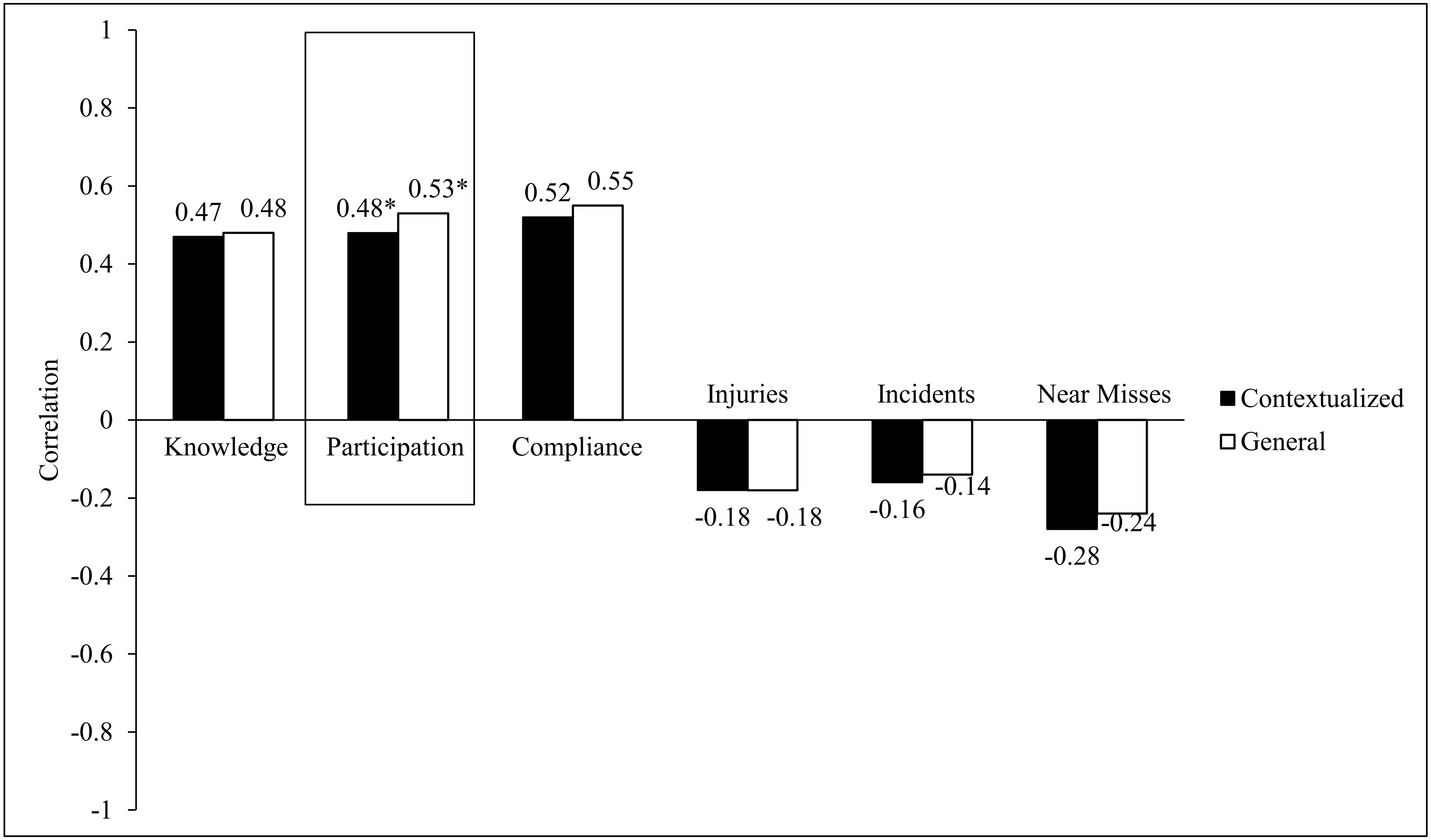

Figure 8. Safety climate correlations for all laboratory types except human subjects/office. *n* = 529. * p < .05.

Management commitment to safety (item 2). Results for the second management commitment to safety item were similarly not supportive of the notion that contextualized items result in stronger relationships. The second management commitment to safety item contextualized for animal biological laboratories was less strongly related with safety compliance (r = .28) compared to the general item (r = .45), Z(180) = -2.52, p = .01. The relationship with near misses for human subjects/office laboratories was the only instance in which this contextualized item significantly outperformed the general item (r = -.29 vs. r = -.09), Z(105) = -2.15, p = .03.

Communication. A large majority of the correlations for the communication item were statistically equivalent. Of those that were significantly different, one was in the expected direction and one was not. The contextualized human subjects/office item was more strongly related to safety knowledge (r = .52) compared to the general item (r = .36), Z(106) = 2.04, p = .04. In contrast, the contextualized mechanical/electrical item was less strongly related to safety participation (r = .38) than the corresponding general item (r = .68), Z(56) = -2.85, p = .004.

Training. Most of the correlations for the training item were also not significantly different. Those that were different were not in the expected direction. There was a significant difference between the two items with safety compliance for the biological laboratory (r = .33 vs. r = .50), Z(184) = -2.80, p = .005. Additionally, compared to the corresponding general item, the contextualized animal biological training item was less strongly related to injuries (r = .00 vs. r = -.14), Z(177) = 1.94, p = .05.

Co-worker safety practices. Results for the co-worker safety practices item were mixed. Contrary to prediction, the contextualized item for mechanical/electrical laboratories

Table 12

Correlations between Management Commitment to Safety Items and the Five Safety Predictors

Dimension	Safety outcome	Contextualized vs. general	Animal biological	Biological	Chemical	Mechanical/ electrical	Human subjects/office
Management commitment (item 1)	Knowledge	Contextualized	.28	.28	.41	.39[a]	.41
		General	.32	.36	.44	.64[a]	.40
	Participation	Contextualized	.31[a]	.35[a]	.32	.37	.36
		General	.45[a]	.46[a]	.43	.56	.45
	Compliance	Contextualized	.33	.38[a]	.45	.39[a]	.44
		General	.34	.54[a]	.54	.71[a]	.52
	Injuries	Contextualized	-.14	-.13	-.17	.08	-.23
		General	-.19	-.21	-.03	-.04	-.15
	Incidents	Contextualized	-.08	-.16	-.17	-.04	-.30
		General	-.14	-.24	-.08	.00	-.33
	Near misses	Contextualized	-.12	-.30	-.24	-.07	-.28
		General	-.14	-.39	-.22	.02	-.21
Management commitment (item 2)	Knowledge	Contextualized	.27	.29	.39	.62	.55
		General	.37	.40	.45	.65	.43
	Participation	Contextualized	.28[a]	.34	.41	.49	.54
		General	.45[a]	.43	.46	.63	.51
	Compliance	Contextualized	.28	.45	.47	.59	.54
		General	.39	.49	.48	.63	.51
	Injuries	Contextualized	-.10	-.09	-.15	-.05	-.19
		General	-.19	-.14	-.03	-.09	-.14
	Incidents	Contextualized	-.13	-.18	-.17	.13	-.32
		General	-.14	-.09	-.04	-.02	-.21
	Near misses	Contextualized	-.13	-.27	-.26	-.17	-.29[a]
		General	-.13	-.17	-.26	.00	-.09[a]

Notes. Item 1 read “My lab manager/PI strictly enforces the safe working procedures in my workgroup.” Item 2 read “My lab manager/PI takes a proactive stance when it comes to safety.” [a] $p < .05$

Table 13

Correlations between the Communication Item and the Five Safety Predictors

Dimension	**Safety outcome**	**Contextualized vs. general**	**Animal biological**	**Biological**	**Chemical**	**Mechanical/ electrical**	**Human subjects/office**
Communication	Knowledge	Contextualized	.38	.34	.49	.39	.52[a]
		General	.35	.35	.56	.46	.36[a]
	Participation	Contextualized	.39	.40	.48	.38[a]	.57
		General	.44	.42	.53	.68[a]	.46
	Compliance	Contextualized	.36	.38	.44	.45	.51
		General	.36	.43	.47	.53	.42
	Injuries	Contextualized	-.09	-.09	-.22	.00	-.21
		General	-.17	-.14	-.18	-.04	-.04
	Incidents	Contextualized	-.13	-.16	-.18	-.02	-.23
		General	-.15	-.11	-.15	-.08	-.22
	Near misses	Contextualized	-.17	-.21	-.29	-.13	-.17
		General	-.12	-.19	-.27	-.07	-.24

Note. [a] $p < .05$

Table 14

Correlations between the Training Item and the Five Safety Predictors

Dimension	Safety outcome	Contextualized vs. general	Animal biological	Biological	Chemical	Mechanical/ electrical	Human subjects/office
Training	Knowledge	Contextualized	.35	.37	.49	.49	.45
		General	.37	.46	.54	.57	.41
	Participation	Contextualized	.32	.36	.35	.45	.49
		General	.41	.43	.37	.51	.42
	Compliance	Contextualized	.34	.33[a]	.41	.50	.54
		General	.36	.50[a]	.47	.63	.53
	Injuries	Contextualized	.00[a]	-.14	-.14	.06	-.23
		General	-.14[a]	-.08	-.17	-.14	-.06
	Incidents	Contextualized	-.02	-.05	-.21	-.04	-.28
		General	-.08	-.07	-.21	-.09	-.23
	Near misses	Contextualized	.06	-.10	-.23	-.06	-.26
		General	-.02	-.14	-.29	-.19	-.22

Note. [a] $p < .05$

was significantly less related with safety knowledge (r = .24), compared to the general item (r = .50), $Z(55) = -1.97$, p = .05. Comparisons of the correlations with safety compliance were similar for biological (r = .32 vs. r = .46), $Z(186) = -2.48$, p = .01, and mechanical/electrical items (r = .31 vs. r = .58), $Z(55) = -2.16$, p = .03. As expected, the contextualized human subjects/office item outperformed the general item in its relationship with safety knowledge (r = .55 vs. r = .33), $Z(105) = 2.62$, p = .009, and participation (r = .50 vs. r = .28), $Z(105) = 2.53$, p = .01. The correlations with injuries for mechanical/electrical laboratory items did not support prediction (r = .13 vs. r = -.22), $Z(55) = 2.42$, p = .02, whereas the correlations for human subjects/office items were in the predicted direction (r = -.35 vs. r = -.17), $Z(105) = -1.93$, p = .05.

Equipment & housekeeping (item 1). Most of the correlations for the first equipment & housekeeping item were statistically equivalent. The direction of the significantly different correlations were opposite of expectations. The general item was significantly more strongly related with safety participation for biological laboratories (r = .28 vs. r = .39), $Z(185) = -2.06$, p = .04. Similar results were found for the correlations with near misses for chemical laboratories (r = -.24 vs. r = -.40), $Z(104) = 2.09$, p = .04.

Equipment & housekeeping (item 2). Results for the second equipment & housekeeping item were more supportive of the expected relationship. However, the differences were inconsistent. The second equipment & housekeeping item was significantly less strongly related with safety knowledge when contextualized for animal biological laboratories (r = .25 vs. r = .40), $Z(175) = -2.34$, p = .02. However, the same comparison for human subjects/office laboratories was in the expected direction (r = .49 vs. r = .30), $Z(104) = 1.97$, p = .05. Relationships with safety participation for animal biological items was also

Table 15

Correlations between the Co-worker Safety Practices Item and the Five Safety Predictors

Dimension	Safety outcome	Contextualized vs. general	Animal biological	Biological	Chemical	Mechanical/ electrical	Human subjects/office
Co-worker safety practices	Knowledge	Contextualized	.25	.23	.31	.24[a]	.55[a]
		General	.23	.33	.29	.50[a]	.33[a]
	Participation	Contextualized	.29	.26	.25	.50	.50[a]
		General	.31	.33	.32	.57	.28[a]
	Compliance	Contextualized	.36	.32[a]	.34	.31[a]	.51
		General	.39	.46[a]	.42	.58[a]	.43
	Injuries	Contextualized	-.15	-.37	-.11	.13[a]	-.35[a]
		General	-.22	-.39	-.21	-.22[a]	-.17[a]
	Incidents	Contextualized	-.22	-.21	-.13	-.12	-.37
		General	-.15	-.21	-.17	-.30	-.27
	Near misses	Contextualized	-.35	-.33	-.25	-.03	-.47
		General	-.28	-.33	-.24	-.20	-.41

Note. [a] $p < .05$

significantly different (r = .27 vs. r = .44), Z(175) = -2.70, p = .007; however, it was not in the expected direction.

Correlation comparisons with near misses, incidents, and injuries were supportive of the predicted relationship. Specifically, the item contextualized for animal biological laboratories was more strongly related with incidents (r = -.09 vs. r = .08), Z(175) = -2.48, p = .01. The comparison with near misses was similar for biological items (r = -.31 vs. r = -.16), Z(186) = -2.42, p = .02. The relationships with injuries for human subjects/office items were also in the predicted direction (r = -.53 vs. r = -.22), Z(104) = -3.23, p = .001.

Involvement. Significant differences in the correlations for the involvement item were also mixed. In line with the expected results, the item contextualized for human subjects/office laboratories was significantly more strongly related with safety knowledge (r = .61 vs. r = .42), Z(104) = 2.92, p = .003. Comparisons of the correlations with safety knowledge and compliance for biological laboratory items were the opposite of what was predicted: safety knowledge (r = .27 vs. r = .41), Z(185) = -2.23, p = .03, and compliance (r = .33 vs. r = .51), Z(185) = -3.02, p = .003. A similar pattern of results was found for animal biological laboratory items in their relationship with safety participation (r = .34 vs. r = .52), Z(173) = -3.35, p = .001.

The significantly different correlations with near misses, incidents, and injuries were in the expected direction. There was a significant difference between the animal biological item and general item in their relationship with near misses (r = -.17 vs. r = -.05), Z(173) = -1.98, p = .05. The same was true for the human subjects/office items and injuries (r = -.30 vs. r = -.14), Z(104) = -2.08, p = .04.

Table 16

Correlations between Equipment & Housekeeping Items and the Five Safety Predictors

Dimension	Safety outcome	Contextualized vs. general	Animal biological	Biological	Chemical	Mechanical/ electrical	Human subjects/office
Equipment & housekeeping (item 1)	Knowledge	Contextualized	.39	.33	.41	.48	.44
		General	.33	.38	.36	.54	.40
	Participation	Contextualized	.37	.28[a]	.29	.41	.39
		General	.42	.39[a]	.30	.52	.42
	Compliance	Contextualized	.41	.43	.33	.48	.45
		General	.41	.50	.40	.64	.51
	Injuries	Contextualized	-.07	-.39	-.19	-.11	-.27
		General	-.14	-.40	-.13	-.11	-.09
	Incidents	Contextualized	.00	-.10	-.16	-.18	-.34
		General	.03	-.13	-.15	-.15	-.29
	Near misses	Contextualized	-.15	-.36	-.24[a]	-.16	-.25
		General	-.13	-.31	-.40[a]	-.14	-.16
Equipment & housekeeping (item 2)	Knowledge	Contextualized	.25	.28[a]	.35	.60	.49[a]
		General	.40	.39[a]	.39	.61	.30[a]
	Participation	Contextualized	.27[a]	.37	.37	.55	.41
		General	.44[a]	.47	.36	.69	.32
	Compliance	Contextualized	.41	.41	.39	.61	.51
		General	.45	.49	.44	.66	.44
	Injuries	Contextualized	-.02	-.29	-.15	-.09	-.53[a]
		General	-.09	-.21	-.15	.01	-.22[a]
	Incidents	Contextualized	-.09[a]	-.15	-.19	-.04	-.52[a]
		General	.08[a]	-.05	-.11	.01	-.35[a]
	Near misses	Contextualized	-.29	-.31[a]	-.32	-.21	-.40
		General	-.17	-.16[a]	-.24	-.05	-.29

Notes. Item 1 read "Equipment is checked to make sure it is free of faults." Item 2 read "Unsafe conditions are promptly corrected in my work area." [a] $p < .05$

Table 17

Correlations between the Involvement Item and Safety Knowledge and the Five Safety Predictors

Dimension	**Safety outcome**	**Contextualized vs. general**	**Animal biological**	**Biological**	**Chemical**	**Mechanical/ electrical**	**Human subjects/office**
Involvement	Knowledge	Contextualized	.40	.27[a]	.43	.63	.61[a]
		General	.42	.41[a]	.43	.45	.42[a]
	Participation	Contextualized	.34[a]	.35	.48	.66	.49
		General	.52[a]	.45	.48	.59	.46
	Compliance	Contextualized	.34	.33[a]	.49	.63	.57
		General	.38	.51[a]	.41	.52	.48
	Injuries	Contextualized	-.24	-.08	-.19	.03	-.30[a]
		General	-.17	-.08	-.15	-.16	-.14[a]
	Incidents	Contextualized	-.10	-.14	-.19	-.14	-.39
		General	-.08	-.03	-.18	.03	-.25
	Near misses	Contextualized	-.17[a]	-.19	-.26	.06	-.28
		General	-.05[a]	-.12	-.26	-.16	-.22

Note. [a] $p < .05$

Rewards. Significant differences for the reward item were generally supportive of the predicted effects. The contextualized human subjects/office item was significantly more strongly related with safety knowledge ($r = .55$ vs. $r = .39$), $Z(103) = 2.38$, $p = .02$, safety participation ($r = .62$ vs. $r = .50$), $Z(103) = 1.93$, $p = .05$, and incidents ($r = -.34$ vs. $r = -.19$), $Z(103) = -2.00$, $p = .05$. However, the relationship for biological laboratories with safety compliance was the opposite ($r = .36$ vs. $r = .49$), $Z(184) = -2.64$, $p = .008$.

Context Comparisons

It was purported that the five laboratories examined in this study are significantly different enough in risks and safety policies and procedures to warrant different contextualized safety climate measures. Follow-up analyses (independent t-tests) were conducted to examine the extent to which the five laboratories varied significantly on perceived risk, injuries, incidents, near misses, and an objective indicator of risk (biosafety level).

Perceived job risk. Overall, the laboratories varied significantly on perceived job risk. An analysis of variance indicated that laboratory type (animal biological, biological, chemical, mechanical/electrical, and human subject/office) had a significant effect on perceived risk, $F(4, 645) = 20.35$, $p < .001$, $\eta^2 = .11$. Human subjects/office laboratory members reported perceiving significantly less job risk ($M = 1.16$, $SD = .45$) compared to members of the four other laboratory types: animal biological ($M = 1.86$, $SD = .83$), $t(290) = -9.32$, $d = -.98$, $p < .001$, biological ($M = 1.60$, $SD = .71$), $t(300) = -6.60$, $d = -.70$, $p < .001$, chemical ($M = 1.99$, $SD = .94$), $t(217) = -8.32$, $d = -1.13$, $p < .001$, and mechanical/electrical ($M = 1.82$, $SD = .90$), $t(217) = -5.23$, $d = -1.03$, $p < .001$. Further, the perceived risk associated with biological laboratories ($M = 1.60$, $SD = .71$) was significantly less than

Table 18

Correlations between the Rewards Item and Safety Knowledge and the Five Safety Predictors

Dimension	**Safety outcome**	**Contextualized vs. general**	**Animal biological**	**Biological**	**Chemical**	**Mechanical/ electrical**	**Human subjects/office**
Rewards	Knowledge	Contextualized	.34	.31	.30	.56	.55[a]
		General	.37	.37	.25	.62	.39[a]
	Participation	Contextualized	.34	.44	.40	.51	.62[a]
		General	.40	.46	.37	.61	.50[a]
	Compliance	Contextualized	.30	.36[a]	.38	.58	.58
		General	.33	.49[a]	.41	.57	.46
	Injuries	Contextualized	-.20	-.20	-.14	-.13	-.21
		General	-.20	-.11	-.16	-.08	-.10
	Incidents	Contextualized	-.18	-.21	-.09	-.11	-.34[a]
		General	-.12	-.20	-.10	-.28	-.19[a]
	Near misses	Contextualized	-.16	-.22	-.11	-.11	-.25
		General	-.12	-.18	-.17	.05	-.13

Note. [a] $p < .05$

animal biological (M = 1.86, SD = .83), t(372) = -3.23, d = -.34, p = .001, chemical (M = 1.99, SD = .94), t(299) = -3.78, d = -.49, p < .001, and mechanical/electrical (M = 1.82, SD = .90), t(217) = -1.95, d = -.29, p = .05. None of the other laboratory types differed significantly from one another with respect to perceived job risk.

Injuries. Laboratory type did not have a significant effect on the self-reported number of injuries, F(4, 646) = 1.85, p = .12, η^2 = .01. There were no significant differences between human subjects/office (M = .15, SD = .66), animal biological (M = .33, SD = 1.12), biological (M = .18, SD = .67), chemical (M = .56, SD = 2.63), or mechanical/electrical laboratory members (M = .38, SD = .97) in the number of reported injuries.

Incidents. An analysis of variance indicated that there were significant differences across laboratory types as related to self-reported incidents, F(4, 638) = 4.27, p = .002, η^2 = .03. The number of incidents was significantly less for human subjects/office (M = .10, SD = .43), compared to animal biological (M = .49, SD = 1.40), t(287) = -3.52, d = -.34, p = .001, biological (M = .26, SD = .74), t(298) = -2.30, d = -.25, p = .02, and chemical laboratories (M = .86, SD = 2.67), t(214) = -2.91, d = -.40, p = .004. Biological laboratory respondents reported significantly fewer incidents (M = .26, SD = .74), compared to animal biological (M = .49, SD = 1.40), t(369) = -2.03, d = -.21, p = .04, and chemical laboratories (M = .86, SD = 2.67), t(296) = -2.29, d = -.35, p = .02, There were no other significant differences in the number of incidents for the five laboratory types.

Near misses. Likewise, there were differences across laboratory types in the number of self-reported near misses, F(4, 643) = 3.94, p = .004, η^2 = .02. The self-reported number of near misses associated with human subjects/office laboratories (M = .27, SD = .84) was significantly less than those associated with animal biological (M = .72, SD = 1.61), t(289) =

-3.10, *d* = -.33, *p* = .002, biological (*M* = .58, *SD* = 1.53), *t*(301) = -2.30, *d* = -.23, *p* = .02, chemical (*M* = 1.19, *SD* = 2.80), *t*(216) = -3.26, *d* = -.45, *p* = .001, and mechanical/electrical (*M* = .78, *SD* = 1.80), *t*(167) = -2.03, *d* = -.41, *p* = .05. Additionally, biological respondents reported significantly fewer near misses (*M* = .58, *SD* = 1.53) than chemical laboratory respondents (*M* = 1.19, *SD* = 2.80), *t*(297) = -2.08, *d* = -.29, *p* = .04. None of the other laboratory types significantly differed in the number of reported near misses.

Biosafety level. The biosafety level of biological laboratory respondents (*Mdn* = 2.00, *n* = 188) did not significantly differ from the animal biosafety level of animal biological laboratory respondents (*Mdn* = 2.00, *n* = 141), *U* = 12780.00, *z* = -.64, *p* = .52, *r* = -.04.

4. SUMMARY AND CONCLUSIONS

Industry-specific items are often included in safety climate measures (Beus et al., 2013; Zohar, 2003; 2010); however, the effectiveness of this measurement approach is uncertain because few researchers have rigorously compared a general safety climate measure to a contextualized measure. The purpose of this study was to provide a rigorous test of the effectiveness of contextualizing a safety climate measure based on the extent to which safety knowledge, behavior, and safety-related events predict a contextualized safety climate measure compared to a general measure. Five contextualized safety climate measures (animal biological, biological, chemical, mechanical/electrical, and human subjects/office) were developed. Thus, the effectiveness of contextualization was assessed five times.

Huang et al. (2013) found that a truck-driving specific safety climate measure added a significant increment in validity (6% and 11%) to the prediction of driving behavior above a general measure; however, the present study indicates that definitive conclusions about industry-specific safety climate measures as universally better predictors should be tempered. Contextualized safety climate measures had stronger relationships with safety knowledge, behavior, and safety-related events in some cases, but not in others. In most cases, the relationships with the general measure and relationships with the context-specific measure were not significantly different, especially for three of the five labs: animal biological, chemical, and mechanical/electrical measures. Contextualization appeared to be most useful for human subjects/office laboratories. The contextualized human subjects/office measure related more strongly to all six predictors than the general measure and this difference was statistically significant for safety knowledge and injuries.

Another objective of the current investigation involved a preliminary assessment of contextualized and general items for seven safety climate dimensions. Each dimension was examined with either one or two items. Most of the general vs. contextualized item-level correlations with predictors were not significantly different from one another, which is consistent with the lack of difference found at the scale level of analysis. When significant differences emerged for the training, co-worker safety practices, and management commitment to safety dimensions, they tended to indicate stronger relationships with the general item or no interpretable pattern. The rewards safety climate dimension did, however, demonstrate relationship patterns consistent with prediction: a majority of the significant relationships indicated that the contextualized item, especially human subjects/office, had a stronger relationship with predictors than the corresponding general item. There were about an equal amount of significantly different correlations in which the general item outperformed the contextualized item and vice versa for co-worker safety practices, equipment & housekeeping, and employee involvement. No consistent pattern emerged for these items. Overall, the results did not support the notion that some safety climate dimensions are more conducive to contextualization than others.

Theoretical Implications

This study contributes to industry-specific safety climate literature by providing a preliminary theoretical explanation for the usefulness of a contextualized approach based on comprehension and recall. Contextualized items purportedly lead to more complete recall, because they aid in the recall process and are more interpretable to respondents. Further research is necessary to directly test if contextualized information facilitates comprehension and recall. Simply asking respondents if the contextualized items were more comprehensible and facilitated recollection of relevant events would provide some initial information about the viability of this theoretical explanation.

The usefulness of contextualized information in safety climate measures might vary because of differences in risk. In this study, five types of laboratories were identified and differentiated based on laboratory-specific risks. Animal biological, biological, chemical, and mechanical/electrical laboratories utilize equipment and materials that can cause bodily harm or even death (DeRoos, 1977; Furr, 2000). The contextualized safety climate measures developed for these laboratory types incorporated some of these risks, including chemical and biohazards, infectious waste, sources of radiation, and dangerous equipment (e.g., power and machine tools, incinerators, lasers, soldering irons, etc.). Understandably, safety in these laboratories is of great importance to universities because major accidents have far-reaching consequences (National Research Council, 2014). Arguably, university laboratories are more regulated than ever before. Most laboratory personnel are required to complete extensive safety training dealing with general and laboratory-specific risks, although training varies across institutions (National Research Council, 2014).

The risks associated with human subjects/office laboratories are minor in comparison. Some of the risks identified for the contextualized human subjects/office measure include electrical, tripping, and fall hazards. Follow up analyses supported the significantly low risk and reported incidents and near misses associated with human subjects/office laboratories compared to the other laboratory types. Given these differences, there is often minimal to no safety procedures or training in place for human subjects/office laboratory personnel. Regulations and training mainly focus on reducing risks for human subject participants, rather than laboratory members (Protection of Human Subjects, 2009).

The usefulness of contextualized information in safety climate measures might vary because of differences in risk and subsequent comprehension and recall. Contextualization assists with comprehension by expanding on the meaning of individual items and helps respondents remember relevant experiences. This might be particularly useful for human subjects/office personnel, because they tend to be less experienced with risk and safety regulations and training. Human subjects/office laboratory personnel might provide a deficient assessment of safety climate when responding to general items because they are unsure of what constitutes a risk in their laboratory and are more likely to question the item's meaning. In turn, they recall and respond based on relatively few (if any) experiences.

Contextualized information might not be as useful at assisting in comprehension and recall for members of other laboratories. Those from other laboratory types might have little difficulty interpreting the meaning of general items because safety is an integral aspect of their work duties and training. They might not need cues to recall specific events because they experience more risks and are trained to recognize and remember them.

The results of this study indicate the circumstances in which there might be value in adding contextualized information to safety climate measures. The results generally indicate that contextualized items might be less effective for those industries that have strict guidelines and policies to follow and risks that are more prevalent. Those individuals who work in risky environments and experience stricter safety regulations might be more likely to appropriately interpret, recall, and respond to general items. There might be value in adding contextualized information when the risks associated with a given industry are less salient. Contextualized information might help respondents from these contexts/industries realize and recognize the risks around them. Future research is necessary to explore these propositions further.

The results of this study differ from previous efforts. Compared to the present study, Huang et al. (2013) conducted the most similar study of industry-specific measure effectiveness to date. They found support for the incremental validity of an industry-specific measure over a general measure in the prediction of a relevant safety outcome. In comparison, this study found inconsistent support for advantages to using an industry-specific measure over a general measure.

There are a variety of potential reasons for the differences observed between the current study and Huang et al.'s (2013) study. First, the study designs were different. In this study, the safety-related variables examined were treated as predictors because they were measured concurrently with safety climate rather than subsequently. Huang et al. conducted a prospective study in which safety climate was treated as a predictor of driving behavior despite measuring both variables concurrently. Safety climate was also used to predict injuries that occurred six months after climate was measured. This allowed for testing the incremental validity explained in injuries of contextualized safety climate over and above general safety climate.

Second, the contextualized measures examined in the current study and Huang et al. (2013) were different. Huang et al. developed entirely new industry-specific items, whereas in this study the contextualized and general items shared the same stems. Given their similarly, measures in the current study might have been more prone to issues with short-term memory effects leading to overly inflated relationships between contextualized and general measures and the various predictors. In comparison, Huang et al.'s (2013) general and industry-specific safety climate items were less similar and potentially less prone to short-term memory effects. However, similarities between general and contextualized items in this study were purposeful to provide a more rigorous, unconfounded test of the inclusion of contextual information in a safety climate measure.

Safety climate dimensions. A majority of the general vs. contextualized item-level correlations with various predictors were not significantly different. However, there are a few notable exceptions. The human subjects/office safety climate measure was more strongly related to multiple predictors across all seven dimensions. This was especially the case for rewards. This finding conflicts with expectations, but is in line with the previous discussion. The reward system for safety in many human subjects/office laboratories might be especially limited, or nonexistent because the risks are minimal. Consequently, human subject/office personnel might be less familiar with the practice of rewarding safe behavior. Contextualized information in relation to rewards might be particularly useful to provide meaning and aid in the recall process. However, this might not be as applicable to personnel from other laboratory types. Members of other laboratories might have more experience with rewards for safe behavior, because they have witnessed or perhaps even benefitted from a reward system. However, this explanation is speculative because these propositions were not directly examined in the current study.

Contextualized information for the following safety climate dimensions: training, management commitment, and communication does not appear to be very helpful. Additionally, patterns of results for the other safety climate dimensions (i.e., co-worker safety practices, employee involvement, and equipment & housekeeping) were inconsistent. For these dimensions, general safety climate items were more strongly related than contextualized items to safety knowledge and behavior. In contrast, contextualized items for these dimensions had significantly stronger relationships than general items with injuries, incidents, and near misses. It would not be appropriate to make any substantive conclusions about the value of adding contextual information to specific safety climate dimensions at this time. This preliminary analysis was limited to one or two items per dimension. More items per dimension must be analyzed in order to make definitive conclusions.

Practical Implications

The main practical implication of this study is determining the usefulness of industry-specific information within safety climate measures. Many applied and academic researchers utilize industry-specific safety climate measures and assume that they are effective as predictors of outcomes. However, prior to this study, a rigorous comparison had not been conducted. The results do not offer definitive support for contextualized safety climate measurement.

It appears that contextualized measures might be most useful in less safety-salient contexts, which should be taken in consideration when deciding between using an industry-specific or general safety climate measure. Contextualization might be most effective for contexts in which general items are less likely to cue relevant memories or enhance comprehension of the items. However, general measures appear to be equally or more effective for those industries that are very risky and tend to be more strictly regulated.

As noted earlier, there are a lot of practical reasons to utilize a general measure of safety climate over an industry-specific one. General measures facilitate comparisons across organizations and industries because they are applicable to all contexts. They are easier to develop and shorter to administer.

Limitations and Future Directions

The present study was limited in a variety of ways. One potential limitation was the cross-sectional design and associated biases. All study variables were collected at the same time (Podsakoff et al., 2003). Cross-sectional designs might bias results because they increase the likelihood that predictor and criterion variables will be remembered and facilitate the use of implicit theories (Podsakoff et al., 2003). A common way to avoid such biases is to temporally separate measures (Podsakoff et al., 2012).

In this study, however, the biases associated with the cross-sectional design appear to be limited. Follow-up analyses of counterbalancing indicated that there was little evidence for order effects. Additionally, any biases resulting from measuring all study variables at the same time would be unlikely to support the hypotheses which focused on differences in the relationships between the two safety climate measures and various safety-related predictors. Method effects associated with the cross-sectional design such as short-term memory are more likely to lead to an inflated relationship between predictors and both safety climate measures, rather than the hypothesized differences. The results for the contextualized human subjects/office measure are especially salient given these considerations. Short-term memory effects are one potential explanation for the difference between the results of this study and Huang et al. (2013). Future research might space out the administration of measures to further limit method effects.

Another limitation of the study design was the measurement and analysis of psychological safety climate rather than workgroup safety climate. By definition, safety climate is a unit-level construct (employees shared perceptions) that should be measured by aggregating individual responses to the workgroup level. Group-level safety climate is more strongly related to safety outcomes compared to psychological safety climate (Beus et al., 2010). Unfortunately, organizational constraints prohibited gathering workgroup (laboratory) identification information. Consequently, this study was restricted to examining psychological safety climate. It remains to be seen if similar results would emerge at the group level of analysis.

Design limitations also prevented linking the survey data to prospective incident data and the research questions that could be answered. Recent meta-analytic findings support safety climate as both a leading and lagging indicator of workplace safety (Beus et al., 2010). It would be also be informative to compare the predictive validity of a contextualized safety climate measure to a general safety climate measure, as well as the incremental validity explained by each measure over and above the other. This would require gathering prospective incident data (organizational records or self-report) and the means to link such data to the safety climate measure data. Unfortunately, organizational constraints prohibited such efforts.

Further avenues for future research include contextualized measure development and assessment. The contextualization approach taken in the current study ensured the only difference between the contextualized measure and the general measure was the provision of context, thus providing a more rigorous comparison of a contextualized measure to a general measure. However, this approach differs from how industry-specific measures have been historically developed by creating entirely new items that incorporate contextual information based on interviews with subject-matter experts. The approach in this study and previous efforts are fundamentally similar; in both cases, safety climate items incorporate information specific to a particular context. It was beyond the scope of this study to determine the best way to develop an industry-specific measure. Future research might be targeted at comparing and contrasting various approaches to contextualization.

Another potential limitation of the measure development technique was the identification and inclusion of contextualized information. Tours of laboratories and a review of the pertinent literature indicate that there are consistent risks across laboratories; however, there are also substantial within-laboratory differences. The contextualized information included in each item was derived based on relevant literature and verified by subject-matter experts. However, it is possible that some of the information was incomplete or not specific enough for individual laboratories.

Conclusion

Safety climate experts advocate including industry-specific items when measuring safety climate. Indeed, a recent summary of the safety climate research called for industry-specific measure development and analysis (Zohar, 2010). In their recent assessment, Huang et al. (2013) found that an industry-specific approach accounts for significant incremental validity in the prediction of relevant outcomes. The purpose of this study was to provide a rigorous test of the effectiveness of an industry-specific safety climate measure based on how well safety knowledge, behavior, and safety-related events predict a contextualized safety climate measure compared to a general safety climate measure. Theoretical arguments for the effectiveness of a contextualized measure were based on enhanced comprehension and recall when completing such measures.

University research laboratory personnel completed one of five contextualized safety climate measures associated with their laboratory, a general measure, and self-reports of safety knowledge, behavior, and outcomes. Only the contextualized human subjects/office laboratory measure was consistently more strongly related to the predictors, which provides some support for the underlying theoretical arguments. Contextualized information might facilitate comprehension and recall for individuals who work in less risky industries. Item-level analyses indicate that contextualization for the rewards dimension of safety climate is particularly effective. Ideally, this study will stimulate further research on the development and assessment of contextualized/industry-specific measures.

REFERENCES

Ashcraft, M. H. & Radvansky, G. A. (2005). *Cognition*. Upper Saddle River, NJ: Pearson Education, Inc

Association of American Colleges and Universities (2010). *Critical thinking VALUE rubric*. Retrieved from https://aacu.org/

Atkinson, R. C., & Shiffrin, R. M. (1968). Human memory: A proposed system and its control processes. *Psychology of Learning and Motivation*, *2*, 89-195. doi:10.1016/S0079-7421(08)60422-3

Baer, M., & Frese, M. (2003). Innovation is not enough: Climates for initiative and psychological safety, process innovations, and firm performance. *Journal of Organizational Behavior*, *24*, 45-68. doi:10.1002/job.179

Belli, R. F., Smith, L. M., Andreski, P. M., & Agrawal, S. (2007). Methodological comparisons between CATI event history calendar and standardized conventional questionnaire instruments. *Public Opinion Quarterly*, *71*, 603-622. doi:10.1093/poq/nfm045

Belson, W. A. (1981). *The design and understanding of survey questions*. Aldershot, England: Gower.

Beus, J. M., Muñoz, G. J., Arthur, W., Jr., & Payne, S. C. (2013). A multilevel construct validation of safety climate. In Leslie A. Toombs (Ed.), *Proceedings of the Seventy-third Annual Meeting of the Academy of Management* (CD), ISSN 1543-8643.

Beus, J. M., Payne, S. C., Bergman, M. E., & Arthur, W. Jr. (2010). Safety climate and injuries: An examination of theoretical and empirical relationships. *Journal of*

Applied Psychology, 95, 713-727. doi:10.1037/a0019164

Biderman, A. D., Cantor, D., Lynch, J. P., & Martin, E. (1986). *Final report of the National Crime Survey redesign program*. Washington, DC: Bureau of Social Science Research.

Bing, M. N., Whanger, J. C., Davison, H. K., & VanHook, J. B. (2004). Incremental validity of the frame-of-reference effect in personality scale scores: A replication and extension. *Journal of Applied Psychology*, *89*, 150-157. doi:10.1037/0021-9010.89.1.150

Bradburn, N. M., Sudman, S., Blair, E., Locander, W., Miles, C., & Singer, E. (1980). *Improving interview method and questionnaire design: Response effects to threatening questions in survey research*. San Francisco, CA: Jossey-Bass.

Cannell, C. F., Marquis, K. H., & Laurent, A. (1977). *A summary of studies of interviewing methodology* (No. 69). US Government Printing Office: Washington, DC.

Cannell, C., Oksenberg, L., Kalton, G., Bischoping, K., & Fowler, F. J. (1989). *New techniques for pretesting survey questions*. Research report. Survey Research Center, University of Michigan, Ann Arbor, MI.

Chen, Z., Lam, W., & Zhong, J. A. (2007). Leader-member exchange and member performance: A new look at individual-level negative feedback-seeking behavior and team-level empowerment climate. *Journal of Applied Psychology*, *92*, 202-212. doi:10.1037/0021-9010.92.1.202

Christian, M. S., Bradley, J. C., Wallace, J. C., & Burke, M. J. (2009). Workplace safety: A meta-analysis of the roles of person and situation factors. *Journal of Applied Psychology*, *94*, 1103-1127. doi:10.1037/a0016172.

Clarke, S. (2006). The relationship between safety climate and safety performance: A meta-analytic review. *Journal of Occupational Health Psychology*, 11, 315-327. doi:10.1037/1076-8998.11.4.315.

Conway, M. A. (1996). Autobiographical knowledge and autobiographical memories. In Rubin, David C. (Ed), *Remembering our past: Studies in autobiographical memory* (pp. 67-93). New York, NY, US: Cambridge University Press.

Day, B. T. (1999). *Using stages of change to examine fear, threat, efficacy, and safety climate perceptions in health care workers who routinely handle needles and sharps.* Unpublished doctoral dissertation, West Virginia University.

Denison, D. R. (1996). What *is* the difference between organizational culture and organizational climate? A native's point of view on a decade of paradigm wars. *Academy of Management Review, 21*, 619-654

DeRoos, R. L. (1977). Environmental health and safety in the academic setting. *American Journal of Public Health*, *67*, 851-854. doi:10.2105/AJPH.67.9.851

Downey, H. K., Hellriegel, D., & Slocum Jr, J. W. (1975). Environmental uncertainty: The construct and its application. *Administrative Science Quarterly*, 20, 613-629. doi:10.2307/2392027

Fiedler, K., Nickel, S., Muehlfriedel, T., & Unkelbach, C. (2001). Is mood congruency an effect of genuine memory or response bias? *Journal of Experimental Social Psychology*, *37*, 201-214. doi:10.1006/jesp.2000.1442

Fillmore, C. J. (1999). A linguistic look at survey research. In M. Sirken et al. (Eds.), *Cognition and survey research* (pp. 183-198). New York, Willey.

Flin, R., Mearns, K., O'Connor, P., & Bryden, R. (2000). Measuring safety climate:

Identifying the common features. *Safety Science*, *34*, 177-192. doi:10.1016/S0925-7535(00)00012-6

Furr, A. K. (2000). *CRC handbook of laboratory safety*. Boca Raton, FL: CRC press.

Gaba, D. M., Singer, S. J., Sinaiko, A. D., Bowen, J. D., & Ciavarelli, A. P. (2003). Differences in safety climate between hospital personnel and naval aviators. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, *45*, 173-185. doi:10.1518/hfes.45.2.175.27238

Gershon, R. R., Vlahov, D., Felknor, S. A., Vesley, D., Johnson, P. C., Delcios, G. L., & Murphy, L. R. (1995). Compliance with universal precautions among health care workers at three regional hospitals. *American Journal of Infection Control*, *23*, 225-236. doi:10.1016/0196-6553(95)90067-5

Glendon, A. I., & Litherland, D. K. (2001). Safety climate factors, group differences and safety behaviour in road construction. *Safety Science*, *39*, 157-188. doi:10.1016/S0925-7535(01)00006-6

Godden, D. R., & Baddeley, A. D. (1975). Context-dependent memory in two natural environments: On land and underwater. *British Journal of Psychology*, *66*, 325-331. doi:10.1111/j.2044-8295.1975.tb01468.x

Gregory, R. L., & Gombrich, E. H. (1973). *Illusion in nature and art*. New York, NY: Charles Scribner's Sons.

Griffin, M.A., & Neal, A. (2000). Perceptions of safety at work: A framework for linking safety climate to safety performance. *Journal of Occupational Health Psychology, 5*, 347-358. doi:10.1037/1076-8998.5.3.347

Harper, L., & Watt, F. (2012). *Laboratory safety culture survey*. Retrieved from http://www.bioraft.com

Heller, D., Ferris, D. L., Brown, D., & Watson, D. (2009). The influence of work personality on job satisfaction: Incremental validity and mediation effects. *Journal of Personality*, *77*, 1051-1084. doi:10.1111/j.1467-6494.2009.00574.x

Hoerger, M. (2013). Z_H: An updated version of Steiger's Z and web-based calculator for testing the statistical significance of the difference between dependent correlations. Retrieved from http://www.psychmike.com/dependent_correlations.php

Huang, Y. H., Zohar, D., Robertson, M. M., Garabet, A., Lee, J., & Murphy, L. A. (2013). Development and validation of safety climate scales for lone workers using truck drivers as exemplar. *Transportation Research Part F: Traffic Psychology and Behaviour*, *17*, 5-19. dio:10.1016/j.trf.2012.08.011

Hunt, R. R., & Ellis, H. C. (2004). *Fundamentals of cognitive psychology*. New York, NY: McGraw-Hill.

Hunter, I. M. L. (1957). *Memory: Facts and fallacies*. Harmondsworth, UK: Penguin books.

Hunthausen, J. M., Truxillo, D. M., Bauer, T. N., & Hammer, L. B. (2003). A field study of frame-of-reference effects on personality test validity. *Journal of Applied Psychology*, *88*, 545-551. doi:10.1037/0021-9010.88.3.545

James, L. R., Hater, J. J., Gent, M. J., & Bruni, J. R. (1978). Psychological climate: Implications from cognitive social learning theory and interactional psychology. *Personnel Psychology, 31,* 781–813.

James, L. R., & Jones, A. P. (1974). Organizational climate: A review of theory and research. *Psychological Bulletin*, *81*, 1096-1112. doi:10.1037/h0037511

Jermier, J. M., Gaines, J., & McIntosh, N. J. (1989). Reactions to physically dangerous work: A conceptual and empirical analysis. *Journal of Organizational Behavior, 10*, 15-33.

Jex, S. M., Swanson, N., & Grubb, P. (2013). *Healthy workplaces*. Hoboken, NJ: John Wiley & Sons, Inc.

Jobe, J. B., Tourangeau, R., & Smith, A. F. (1993). Contributions of survey research to the understanding of memory. *Applied Cognitive Psychology*, *7*, 567-584. doi:10.1002/acp.2350070703

Krispin, J. V. (1997). The construction and validation of a measure of safety climate: Exploring the link between attitudes and perceptions around safety and safe performance. Unpublished doctoral dissertation, Temple University.

Krosnick, J. A., & Alwin, D. F. (1987). An evaluation of a cognitive theory of response-order effects in survey measurement. *Public Opinion Quarterly*, *51*, 201-219. doi:10.1086/269029

Krosnick, J. A., & Presser, S. (2010). Question and questionnaire design. In Marsden, P. V., & Wright, J. D. (Eds.), *Handbook of survey research* (pp. 263-313). Bingley, UK: Emerald Group Publishing.

LaFollette, W. R., & Sims Jr, H. P. (1975). Is satisfaction redundant with organizational climate? *Organizational Behavior and Human Performance*, *13*, 257-278. doi:10.1016/0030-5073(75)90049-5

Lee, J., Huang, Y. H., Robertson, M. M., Murphy, L. A., Garabet, A., & Chang, W. R. (2014). External validity of a generic safety climate scale for lone workers across different industries and companies. *Accident Analysis & Prevention*, *63*, 138-145. doi:10.1016/j.aap.2013.10.013

Lessler, J. T., Tourangeau, R., & Salter, W. (1989). Questionnaire design in the cognitive research laboratory. *Vital & Health Statistics*, Washington, DC: Government Printing

Office.

Lewin, K. (1951). Formalization and progress in psychology. In Cartwright, D. (Ed.), *Field theory in social science*. New York, NY: Harper.

Lievens, F., De Corte, W., & Schollaert, E. (2008). A closer look at the frame-of-reference effect in personality scale scores and validity. *Journal of Applied Psychology*, *93*, 268-279. doi:10.1037/0021-9010.93.2.268

MacDonald, M. C., Pearlmutter, N. J., & Seidenberg, M. S. (1994). The lexical nature of syntactic ambiguity resolution. *Psychological Review*, *101*, 676-703. doi:2048/10.1037/0033-295X.101.4.676

Melton, A. W. (1963). Implications of short-term memory for a general theory of memory. *Journal of Verbal Learning and Verbal Behavior*, *2*, 1-21. doi:10.1016/S0022-5371(63)80063-8

Messick, S. (1995). Validity of psychological assessment: Validation of inferences from persons' responses and performances as scientific inquiry into score meaning. *American Psychologist*, *50*, 741-749. doi:10.1037/0003-066X.50.9.741

Michigan State University. (2014). Biological safety manual. Retrieved from http://www.orcbs.msu.edu/

Mischel, W., & Shoda, Y. (1995). A cognitive-affective system theory of personality: reconceptualizing situations, dispositions, dynamics, and invariance in personality structure. *Psychological Review*, *102*, 246-258. doi:10.1037/0033-295X.102.2.246

Morrison, E. W., Wheeler-Smith, S. L., & Kamdar, D. (2011). Speaking up in groups: A cross-level study of group voice climate and voice. *Journal of Applied Psychology*, *96*, 183-191. doi:10.1037/a0020744

Mount M. K., & Barrick M. R. (2007). *Personal characteristics inventory*. Libertyville, IL: Wonderlic, Inc.

Myers, D. G. (2014). *Exploring psychology*. New York, NY: Worth Publishers.

Nahrgang, J. D., Morgeson, F. P., & Hofmann, D. A. (2011). Safety at work: A meta-analytic investigation of the link between job demands, job resources, burnout, engagement, and safety outcomes. *Journal of Applied Psychology*, *96*, 71-94. doi:10.1037/a0021484

National Research Council (2014). *Safe science: promoting a culture of safety in academic chemical research*. Washington, DC: The National Academies Press.

Neal, A., & Griffin, M. A. (2006). A study of the lagged relationships among safety climate, safety motivation, safety behavior, and accidents at the individual and group levels. *Journal of Applied Psychology*, *91*, 946-953. doi:10.1037/0021-9010.91.4.946

Occupational Safety and Health Administration. (2012). Laboratories: OSHA standards. Retrieved from http://www.osha.gov.

Occupational Safety and Health Administration (1990). Occupational exposure to hazardous chemicals in laboratories (Part No. 1910). Retrieved from http://www.osha.gov.

Ostroff, C., Kinicki, A. J., & Muhammad, R. S. (2012). Organizational culture and climate. In N. Schmitt, S. Highhouse, & I. Weiner (Eds.) *Handbook of psychology* (Vol. 12): *Industrial and organizational psychology* (pp. 643-676). Hoboken, NJ: John Wiley & Sons Inc.

Pettigrew, A. M. (1979). On studying organizational cultures. *Administrative Science Quarterly*, *24*, 570-581. doi:10.2307/2392363

Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology*, *88*, 879-903. doi:2048/10.1037/0021-9010.88.5.879

Podsakoff, P. M., MacKenzie, S. B., & Podsakoff, N. P. (2012). Sources of method bias in social science research and recommendations on how to control it. *Annual Review of Psychology*, *63*, 539-569. doi:10.1146/annurev-psych-120710-100452

Princeton University. (2014). Laboratory safety manual. Retrieved from http://web.princeton.edu/sites/ehs/labsafetymanual/

Pritchard, R. D., & Karasick, B. W. (1973). The effects of organizational climate on managerial job performance and job satisfaction. *Organizational Behavior and Human Performance*, 9, 126-146. doi:10.1016/0030-5073(73)90042-1

ProAct Safety. (2015). Cultural and organizational safety assessments. Retrieved from http://proactsafety.com/

Protection of Human Subjects, 45 C.F.R. § 46 (2009).

Rousseau. D. M. (1988). The construction of climate in organizational research. In C. L. Cooper & I. T. Robertson (Eds.). *International review of industrial and organizational psychology* (Vol. 3. pp. 139-158). New York, NY: Wiley.

Schaeffer, N. C. (1991). Hardly ever or constantly? Group comparisons using vague quantifiers. *Public Opinion Quarterly*, *55*, 395-423. doi:10.1086/269270

Schank, R. C., & Abelson, R. P. (1977). *Scripts, plans, goals, and understanding*. Hillsdale, NJ: Erlbaum.

Schmit, M. J., Ryan, A. M., Stierwalt, S. L., & Powell, A. B. (1995). Frame-of-reference effects on personality scale scores and criterion-related validity. *Journal of Applied Psychology*, *80*, 607-620. doi:10.1037/0021-9010.80.5.607

Schneider, B. (1975). Organizational climates: An essay. *Personnel Psychology*, *28*, 447-479. doi:10.1111/j.1744-6570.1975.tb01386.x

Schneider, B., Ehrhart, M. G., & Macey, W. H. (2013). Organizational climate and culture. *Annual Review of Psychology*, *64*, 361-388. doi:10.1146/annurev-psych-113011-143809

Schneider, B., Macey, W. H., Lee, W. C., & Young, S. A. (2009). Organizational service climate drivers of the American Customer Satisfaction Index (ACSI) and financial and market performance. *Journal of Service Research*, *12*, 3-14. doi:10.1177/1094670509336743

Schneider, B., & Reichers, A. E. (1983). On the etiology of climates. *Personnel Psychology, 36,* 19–39.

Schneider, B., & Snyder, R. A. (1975). Some relationships between job satisfaction and organization climate. *Journal of Applied Psychology*, *60*, 318-328. doi:10.1037/h0076756

Shaffer, J. A., & Postlethwaite, B. E. (2012). A matter of context: A meta-analytic investigation of the relative validity of contextualized and noncontextualized personality measures. *Personnel Psychology*, *65*, 445-493. doi:10.1111/j.1744-6570.2012.01250.x

Smyth, J. D., Dillman, D. A., Christian, L. M., & Stern, M. J. (2006). Comparing check-all and forced-choice question formats in web surveys. *Public Opinion Quarterly*, *70*, 66-77. doi:10.1093/poq/nfj007

Spector, P. E. (1988). Development of the work locus of control scale. *Journal of Occupational Psychology*, *61*, 335-340. doi:10.1111/j.2044-8325.1988.tb00470.x

Steiger, J. H. (1980). Tests for comparing elements of a correlation matrix. *Psychological Bulletin*, *87*, 245-251. doi:10.1037/0033-2909.87.2.245

Texas A&M University. (2012). EHS laboratory safety inspection checklist. Retrieved from https://ehsd.tamu.edu/Pages/LabSafety.aspx

Texas A&M University. (2009). Laboratory safety manual. Retrieved from https://ehsd.tamu.edu/Pages/LabSafety.aspx

Texas Tech University. (n.d.). Laboratory safety manual. Retrieved from http://www.depts.ttu.edu/ece/

The Ohio State University. (2014). Institution laboratory biosafety manual. Retrieved from http://ehs.osu.edu/manuals.aspx

Thurstone, L. L. (1927). A law of comparative judgment. *Psychological Review*, *34*, 273-286. doi:10.1037/h0070288

Tourangeau, R. (1984). Cognitive science and survey methods. In T. Jabine, M. Straf, J. Tanur, & R. Tourangeau (Eds.), *Cognitive aspects of survey design: Building a bridge between disciplines* (pp. 73-100). Washington, DC: National Academy Press.

Tourangeau, R., & Bradburn, N. B. (2010). The psychology of survey response. In Marsden, P. V., & Wright, J. D. (Eds.), *Handbook of survey research* (pp. 315-346). Bingley, UK: Emerald Group Publishing.

Tourangeau, R., & Rasinski, K. A. (1988). Cognitive processes underlying context effects in attitude measurement. *Psychological Bulletin*, 103, 299-314. doi:10.1037/0033-2909.103.3.299

Tourangeau, R., Rips, L. J., & Rasinski, K. (2000). *The psychology of survey response*. New York, NY: Cambridge University Press.

University of Texas at Austin. (2013). Laboratory safety manual. Retrieved from http://www.utexas.edu/safety/ehs/

U.S. Bureau of Labor Statistics. (2013a). *Census of fatal occupational injuries*. Washington, DC: Government Printing Office. Retrieved from http://www.bls.gov

U.S. Bureau of Labor Statistics. (2013b). *Nonfatal occupational injuries and illnesses requiring days away from work, 2012*. Washington, DC: Government Printing Office. Retrieved from www.bls.gov

U.S. Department of Health and Human Services. (2009). *Biosafety in microbiological and biomedical laboratories*. Washington, DC: Government Printing Office. Retrieved from http://www.cdc.gov

Varonen, U., & Mattila, M. (2000). The safety climate and its relationship to safety practices, safety of the work environment, and occupational accidents in eight wood-processing companies. *Accident Analysis & Prevention*, *32*, 761-769. doi:10.1016/S0001-4575(99)00129-3

West Virginia University. (2012). Department of physics: Laboratory safety plan. Retrieved from http://physics.wvu.edu/

Wills, A. R., Watson, B., & Biggs, H. C. (2006). Comparing safety climate factors as predictors of work-related driving behavior. *Journal of Safety Research*, *37*, 375-383. doi:10.1016/j.jsr.2006.05.008

Wright, J. C., & Mischel, W. (1987). A conditional approach to dispositional constructs: The local predictability of social behavior. *Journal of Personality and Social Psychology*, *53*, 1159-1177. doi:10.1037/0022-3514.53.6.1159

Wu, T. C., Chen, C. H., & Li, C. C. (2008). A correlation among safety leadership, safety climate and safety performance. *Journal of Loss Prevention in the Process Industries*, *21*, 307-318. doi:10.1016/j.jlp.2007.11.001

Zohar, D. (2003). Safety climate: Conceptual and measurement issues. In Quick, J.C., Tetrick, L.E. (Eds.), *Handbook of occupational health psychology* (pp. 123-142). Washington, DC: American Psychological Association.

Zohar, D. (1980). Safety climate in industrial organizations: Theoretical and applied implications. *Journal of Applied Psychology*, *65*, 96-102. doi:10.1037/0021-9010.65.1.96

Zohar, D. (2010). Thirty years of safety climate research: Reflections and future directions. *Accident Analysis & Prevention*, *42*, 1517-1522. doi:10.1016/j.aap.2009.12.019

APPENDIX A

GENERAL SAFETY CLIMATE MEASURE

Thinking of your current workgroup, please read the statements listed below and mark the response that indicates the extent to which you agree with each statement.	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
1. My lab manager/PI strictly enforces the safe working procedures in my workgroup.	1	2	3	4	5
2. My lab manager/PI takes a proactive stance when it comes to safety.	1	2	3	4	5
3. Safety issues are openly discussed between my lab manager/PI and my workgroup.	1	2	3	4	5
4. There is adequate safety training in my workgroup.	1	2	3	4	5
5. My co-workers always follow safety procedures.	1	2	3	4	5
6. Equipment is checked to make sure it is free of faults.	1	2	3	4	5
7. Unsafe conditions are promptly corrected in my work area.	1	2	3	4	5
8. My lab manager/PI promotes employees' involvement in safety related matters.	1	2	3	4	5
9. My lab manager/PI praises safe work behavior.	1	2	3	4	5

APPENDIX B

ANIMAL BIOLOGICAL LABORATORIES SAFETY CLIMATE MEASURE

Do you work in an animal biological laboratory? These laboratories are

- classified as **Animal Biosafety Level 1, 2, 3, or 4**.
- regulated by the Institutional Animal Care and Use Committee (IACUC).
- Radiation *may* be a hazard of the work involved (e.g., the use of x-ray equipment).

Yes (direct to the animal biological lab measure)

No (direct to the biological lab question)

Thinking of the research laboratory (lab) that you work in, the people you work with in the lab (co-workers), and the people you report to (lab manager, Principal Investigator (PI) of the lab), please read the statements listed below and mark the response that indicates the extent to which you agree with each statement.

Note – if YOU are a lab manager/PI please respond based on your own behavior.

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
1	2	3	4	5

1. My lab manager/PI strictly enforces the safe working procedures in my workgroup. This includes:
   - Corrects unsafe work practices (e.g., stops a lab member from using an x-ray machine without their personal dosimeter).
   - Does not tolerate a deviation from safe work practices (e.g., sends lab members home to change shoes if they are wearing open-toe shoes).
   - Dismissing lab members from the lab who have a major safety violation that could have been prevented (e.g., leaving animal cages open) or repeated instances of unsafe work behavior (e.g., animal bites caused by improper handling).

2. My lab manager/PI takes a proactive stance when it comes to safety. For example,

- Develops and institutes practices to deal with potential safety incidents before they occur (e.g., practices for avoiding inhalation of hazardous aerosols).
- Emphasizes the importance of safety to all new lab members when they join the lab.
- Raises safety concerns when planning and developing research projects and studies.
- Considers the safety ramifications before introducing a new biological or equipment hazard.

3. Safety issues are openly discussed between my lab manager/PI and my workgroup. For instance, we
   - Discuss improper use of personal protective equipment (PPE) and other equipment in the lab.
   - Discuss proper animal care including handling, feeding, cage cleaning, and disposal.
   - Share lessons learned following a safety-related incident in our lab or other labs (e.g., severe illness and deaths caused by exposure).

4. There is adequate safety training in my workgroup. Some of the things that we could be informed about and given initial and refresher training on include:
   - Standards and guidelines described in the following books:
     - Center for Disease Control's (CDC) *Biosafety in Microbiological and Biomedical Laboratories*
     - *U.S. Department of Health and Human Services NIH Guidelines for Research Involving Recombinant or Synthetic Nucleic Acid and Molecules*
   - The nature of animal, biological (e.g., infectious material), and/or equipment hazards and how to protect ourselves.
   - Proper detection and response to a biohazard release.
   - How to respond to safety incidents ranging from minor to severe.

5. My co-workers always follow safety procedures. This includes

   The use of PPE:
   - Wear appropriate clothes in the laboratory (i.e., closed toe shoes, laboratory coat/smock, and full-length shirts and pants)
   - Don appropriate PPE when handling animals, risky equipment, chemicals, and biohazards (e.g., goggles, face masks, visors, gloves/gauntlets, aprons, respirators, etc.).

   Other standard animal safety procedures:
   - Use of biosafety cabinet when working with biohazards.
   - Use of fume hoods when working with biohazards, chemicals, radioactive material, and any other material that releases hazardous aerosols.
   - Store, label, and date biohazards and chemicals appropriately.
   - Appropriate animal cage decontamination, cleaning, and washing.
   - Dispose of biohazardous/infectious waste and animals properly.
   - Respond and react to infectious material spills and releases according to procedures.
   - Do not eat in the lab and do not store food with laboratory specimens.
   - Do not pipette by mouth.
   - Safety handling and disposal of sharps.
   - Decontamination of equipment, workspaces, and infectious material.
   - Document safety-related issues and concerns.
   - Operate equipment and work with animals only after receiving necessary training.

6. Equipment in my lab is checked to make sure it is free of faults (a list of <u>some</u> of the equipment and furniture that is likely to be in your lab is provided below).
   - Biosafety cabinets
   - Centrifuges
   - Autoclaves
   - Animal cages
   - Cage washers (rack washer, cabinet washer, tunnel washer)
   - Incinerators
   - Fume hoods
   - Power and machine tools (e.g., saws, drills, cutting tools, welding equipment, solder, table saw, band saw, press, lathe, milling machine, etc.)
   - X-ray equipment
   - Burners and hot plates
   - Refrigerators/Freezers
   - Compressed gas cylinders
   - Distillations and condensers
   - Ovens
   - Heating baths
   - Stills
   - Glassware
   - Containers and carts
   - Base units and work tops

7. Unsafe conditions are promptly corrected in my work area. For instance,
   - The lab (including animal cages) is cleaned regularly and clutter is removed.
   - Work surfaces and equipment are decontaminated promptly after completion of work.
   - Animal waste and infectious material spills and releases are promptly taken care of.
   - Biohazardous material and chemicals are promptly and appropriately stored.
   - Hazardous equipment and machinery are turned off when not in use.
   - Electrical circuits, components, and equipment are grounded before and after use.
   - Sharps and broken glassware are promptly disposed of.

8. My lab manager/PI promotes lab members' involvement in safety-related matters. This includes
   - Confer with us about safety concerns and new training for equipment (e.g., x-ray machine) that may be needed.
   - Discuss with us the best way to comply with new safety regulations imposed by the university and regulatory agencies.
   - Seek input from my workgroup when developing new safety-related procedures (e.g., handling animals).
   - Listen attentively to lab members' safety concerns and seek solutions.
   - Discuss safety in lab meetings.

9. My lab manager/PI praises safe work behavior. Some of the ways he/she might do this are
   - Provide positive feedback when working safely (e.g., proper use of PPE).
   - Recognize lab members for their safe behavior.
   - Give lab members who conduct safe work behavior more discretion and authority (e.g., they are allowed to operate more hazardous equipment).

APPENDIX C

BIOLOGICAL LABORATORIES CLIMATE MEASURE

Do you work in a biological laboratory? These laboratories

- involve the use of **biological agents/materials**.
- are classified as **Biosafety Level (BSL) 1, 2, 3, or 4**.
- conduct research involving "pathogens and potential pathogens of humans, animals, or plants; materials potentially containing human pathogens (including human blood, saliva, tissue, and cell lines; non-human primate blood, tissue, and cell lines); recombinant DNA (and RNA), including creation or use of transgenic plants and animals; select agents and toxins including strains and amounts exempted from the select agent regulations; or any material requiring a CDC import license or a USDA permit" ("Biohazards in research," 2012). Radioactivity is also a common hazard in this environment.
- are regulated by the Institutional Biosafety Committee (IBC).
- Radiation *may* be a hazard of the work involved (e.g., the use of x-ray equipment).

Yes (direct to the biological lab measure)

No (direct to the chemical lab question)

Thinking of the research laboratory (lab) that you work in, the people you work with in the lab (co-workers), and the people you report to (lab manager, Principal Investigator (PI) of the lab), please read the statements listed below and mark the response that indicates the extent to which you agree with each statement.

Note – if YOU are a lab manager/PI please respond based on your own behavior.

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
1	2	3	4	5

1. My lab manager/PI strictly enforces the safe working procedures in my workgroup. This includes:
    - Corrects unsafe work practices (e.g., stops lab member from eating in the lab).
    - Does not tolerate a deviation from safe work practices (e.g., sends lab members home to change shoes if they are wearing open-toe shoes).
    - Dismisses lab members from the lab who have a major safety violation that could have been prevented (e.g., an overexposure to high levels of radiation) or repeated instances of unsafe work behavior (e.g., improper biohazardous material disposal).

2. My lab manager/PI takes a proactive stance when it comes to safety. For example,
    - Develops and institutes practices to deal with potential safety incidents before they occur (e.g., practices for avoiding accidental exposure to infectious agents).
    - Emphasizes the importance of safety to all new lab members when they join the lab.
    - Raises safety concerns when planning and developing research projects and studies.
    - Considers the safety ramifications before introducing a new biological or equipment hazard.

3. Safety issues are openly discussed between my lab manager/PI and my workgroup. For instance, we
    - Discuss improper use of personal protective equipment (PPE) and other equipment in the lab.
    - Discuss proper biohazardous material handling, labeling, storage, and disposal.
    - Share lessons learned following a safety-related incident in our lab or other labs (e.g., severe illness and deaths caused by exposure).

4. There is adequate safety training in my workgroup. Some of the things that we could be informed about and given initial and refresher training on include:
    - Standards and guidelines described in the following books:
        - Center for Disease Control's (CDC) *Biosafety in Microbiological and Biomedical Laboratories*
        - *U.S. Department of Health and Human Services NIH Guidelines for Research Involving Recombinant or Synthetic Nucleic Acid and Molecules*
    - The nature of biological (e.g., infectious) material and/or equipment hazards and how to protect ourselves.
    - Proper detection and response to a biohazard release.
    - How to respond to safety incidents ranging from minor to severe.

5. My co-workers always follow safety procedures. This includes
    The use of PPE:
    - Wear appropriate clothes in the laboratory (i.e., closed toe shoes, laboratory coat/smock, and full-length shirts and pants)
    - Don appropriate PPE when handling risky equipment, radioactive materials, chemicals, and biohazards (e.g., chemical splash goggles, gloves, hot mitts, aprons, respirators, etc.).

    Other standard biosafety procedures:
    - Use of biosafety cabinet when working with biohazards.
    - Use of fume hoods when working with chemicals, radioactive material, and any other material that releases hazardous aerosols.
    - Store, label, and date biohazards and chemicals appropriately.
    - Dispose of biohazardous/infectious waste properly.
    - Respond and react to infectious material spills and releases according to procedures.

- Do not eat in the lab and do not store food with laboratory specimens.
- Do not pipette by mouth.
- Safety handling and disposal of sharps.
- Decontamination of equipment, workspaces, and infectious material.
- Document safety-related issues and concerns.
- Operate equipment only after receiving necessary training.

6. Equipment in my lab is checked to make sure it is free of faults (a list of <u>some</u> of the equipment that is likely to be in your lab is provided below).
    - Biosafety cabinets
    - Centrifuges
    - Autoclaves
    - Fume hoods
    - Lasers
    - Hydraulically- or pneumatically-driven equipment
    - Power and machine tools (e.g., saws, drills, cutting tools, welding equipment, solder, table saw, band saw, press, lathe, milling machine, etc.)
    - X-ray equipment
    - Exercise equipment (e.g., treadmill, weightlifting equipment, stationary bicycles)
    - Burners and hot plates
    - Refrigerators/Freezers
    - Compressed gas cylinders
    - Distillations and condensers
    - Ovens
    - Heating baths
    - Hydrostatic weighing tank
    - Stills
    - Glassware
    - Containers and carts
    - Base units and work tops

7. Unsafe conditions are promptly corrected in my work area. For instance,
    - The lab is cleaned regularly and clutter is removed.
    - Work surfaces and equipment are decontaminated promptly after completion of work.
    - Infectious material spills and releases are promptly taken care of.
    - Biohazards and chemicals are promptly and appropriately stored.
    - Lasers and other hazardous equipment and machinery are turned off when not in use.
    - Electrical circuits, components, and equipment are grounded before and after use.
    - Sharps and broken glassware are promptly disposed of.

8. My lab manager/PI promotes lab members' involvement in safety-related matters. This includes
    - Confer with us about safety concerns and new training for equipment (e.g., band saw) that may be needed.
    - Discuss with us the best way to comply with new safety regulations imposed by the university and regulatory agencies.
    - Seek input from my workgroup when developing new safety-related procedures (e.g., proper disposal of biohazardous waste).
    - Listen attentively to lab members' safety concerns and seek solutions.
    - Discuss safety in lab meetings.

9. My lab manager/PI praises safe work behavior. Some of the ways he/she might do this are

- Provide positive feedback when working safely (e.g., proper use of PPE).
- Recognize lab members for their safe behavior.
- Give lab members who conduct safe work behavior more discretion and authority (e.g., they are allowed to operate more hazardous equipment).

APPENDIX D

CHEMICAL LABORATORIES SAFETY CLIMATE MEASURE

Do you work in a chemical laboratory? These laboratories

- use **hazardous chemicals** including "cancer-causing agents (carcinogens), toxins that may affect the liver, kidney, or nervous system, irritants, corrosives, and sensitizers, as well as agents that act on the blood system or damage the lungs, skin, eyes, or mucous membranes" ("OSHA factsheet," 2011). A list of chemical hazards and examples is provided below.
- may potentially be categorized by **Chemical Safety Level 1, 2, 3, or 4**.
- are regulated by Environmental Health and Safety (EHS) industrial hygiene group.
- Radiation *may* be a hazard of the work involved (e.g., the use of radioactive material)

Type of chemical hazard	**Examples**	
Carcinogens	Asbestos Benzene Tobacco smoke	Hexavalent Chromium Aflatoxins Carbon tetrachloride
Toxins	Hydrogen cyanide Hydrogen sulfide Nitrogen dioxide Ricin Organophosphate pesticides	Arsenic Mercury Lead Formaldehyde
Irritants	Ammonia Formaldehyde Halogens Sulfur dioxide	Poison ivy Dust Pollen Mold
Acidic corrosives	Hydrochloric acid Nitric Acid Sulfuric acid	Acetic Acid Propionic acid
Alkaline, or basic, corrosives	Sodium hydroxide	Potassium hydroxide
Corrosive dehydrating agents	Phosphorous pentoxide	Calcium oxide

Corrosive oxidizing agents	Halogen gases Hydrogen peroxide (concentrated)	Perchloric acid
Organic corrosive	Butylamine	
Sensitizers	Isocyanates Nickel salts Beryllium compounds	Formaldehyde Diazomethane Latex

Yes (direct to the chemical lab measure)

No (direct to the mechanical/electrical lab question)

Thinking of the research laboratory (lab) that you work in, the people you work with in the lab (co-workers), and the people you report to (lab manager, Principal Investigator (PI) of the lab), please read the statements listed below and mark the response that indicates the extent to which you agree with each statement.

Note – if YOU are a lab manager/PI please respond based on your own behavior.

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
1	2	3	4	5

1. My lab manager/PI strictly enforces the safe working procedures in my workgroup. This includes:
   - Corrects unsafe work practices (e.g., stops lab member from eating in the lab).
   - Does not tolerate a deviation from safe work practices (e.g., sends lab members home to change shoes if they are wearing open-toe shoes).
   - Dismisses lab members from the lab who have a major safety violation that could have been prevented (e.g., an injury caused by the improper use of machinery) or repeated instances of unsafe work behavior (e.g., storing incompatible chemicals together).

2. My lab manager/PI takes a proactive stance when it comes to safety. For example,
   - Develops and institutes practices to deal with potential safety incidents before they occur (e.g., practices for avoiding electric shock).
   - Emphasizes the importance of safety to all new lab members when they join the lab.

- Raises safety concerns when planning and developing research projects and studies.
- Considers the safety ramifications before introducing a new chemical or equipment hazard.

3. Safety issues are openly discussed between my lab manager/PI and my workgroup. For instance, we
   - Discuss improper use of personal protective equipment (PPE) and other equipment in the lab.
   - Discuss proper chemical handling, labeling, storage, and disposal.
   - Share lessons learned following a safety-related incident in our lab or other labs (e.g., severe injuries and deaths caused by improper chemical handling).

4. There is adequate safety training in my workgroup. Some of the things that we could be informed about and given initial and refresher training on include:
   - Standards and guidelines described in the following:
     - Texas A&M EHS *Chemical Laboratory Safety and Hazard Communication Compliance Manual*
     - *TAMU Safety Manual: Chemical Safety*
   - The nature of chemical and/or equipment hazards and how to protect ourselves.
   - Proper detection and response to a chemical release.
   - How to respond to safety incidents ranging from minor to severe.

5. My co-workers always follow safety procedures. This includes
   The use of PPE:
   - Wear appropriate clothes in the laboratory (i.e., closed toe shoes, laboratory coat/smock, and full-length shirts and pants)
   - Don appropriate PPE when handling risky equipment, radioactive materials, and chemicals (e.g., chemical splash goggles, gloves, hot mitts, aprons, respirators, etc.).

   Other standard chemical safety procedures:
   - Use of fume hoods when working with chemicals, radioactive material, and any other material that releases hazardous aerosols.
   - Store, label, and date chemicals appropriately.
   - Dispose of waste properly.
   - Respond and react to chemical spills and releases according to procedures.
   - Do not eat in the lab and do not store food with laboratory specimens.
   - Do not pipette by mouth.
   - Safety handling and disposal of sharps.
   - Decontamination of equipment and workspaces.
   - Document safety-related issues and concerns.
   - Operate equipment only after receiving necessary training.

6. Equipment in my lab is checked to make sure it is free of faults (a list of <u>some</u> of the equipment that is likely to be in your lab is provided below).
   - Fume hoods
   - Refrigerators/Freezers

- Autoclaves
- Biosafety cabinets
- Centrifuges
- Lasers
- Hydraulically- or pneumatically-driven equipment
- Power and machine tools (e.g., saws, drills, cutting tools, welding equipment, solder, table saw, band saw, press, lathe, milling machine, etc.)
- Burners and hot plates
- Compressed gas cylinders
- Distillations and condensers
- Ovens
- Heating baths
- Stills
- Glassware
- Containers and carts
- Base units and work tops
- Storage cabinets

7. Unsafe conditions are promptly corrected in my work area. For instance,
   - The lab is cleaned regularly and clutter is removed.
   - Work surfaces and equipment are decontaminated promptly after completion of work.
   - Non-chemical and chemical spills are promptly taken care of.
   - Chemicals and radioactive material are promptly and appropriately stored.
   - Lasers and other hazardous equipment and machinery are turned off when not in use.
   - Electrical circuits, components, and equipment are grounded before and after use.
   - Sharps and broken glassware are promptly disposed of.

8. My lab manager/PI promotes lab members' involvement in safety-related matters. This includes
   - Confer with us about safety concerns and new training for equipment (e.g., laser) that may be needed.
   - Discuss with us the best way to comply with new safety regulations imposed by the university and regulatory agencies.
   - Seek input from my workgroup when developing new safety-related procedures (e.g., proper disposal of radioactive waste).
   - Listen attentively to lab members' safety concerns and seek solutions.
   - Discuss safety in lab meetings.

9. My lab manager/PI praises safe work behavior. Some of the ways he/she might do this are
   - Provide positive feedback when working safely (e.g., proper use of PPE).
   - Recognize lab members for their safe behavior.
   - Give lab members who conduct safe work behavior more discretion and authority (e.g., they are allowed to operate more hazardous equipment).

APPENDIX E

MECHANICAL/ELECTRICAL LABORATORIES SAFETY CLIMATE MEASURE

Do you work in **mechanical and/or electrical** laboratory? These laboratories

- DO NOT involve biological or chemical hazards
- do involve the use of **mechanical/electrical equipment** found in a machine shop (e.g., experimental physics or mechanical engineering labs).

Yes (direct to the mechanical/electrical measure)

No (direct to the office lab question)

Thinking of the research laboratory (lab) that you work in, the people you work with in the lab (co-workers), and the people you report to (lab manager, Principal Investigator (PI) of the lab), please read the statements listed below and mark the response that indicates the extent to which you agree with each statement.

Note – if YOU are a lab manager/PI please respond based on your own behavior.

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
1	2	3	4	5

1. My lab manager/PI strictly enforces the safe working procedures in my workgroup. This includes:
   - Corrects unsafe work practices (e.g., stops lab member from eating in the lab).
   - Does not tolerate a deviation from safe work practices (e.g., sends lab members home to change shoes if they are wearing open-toe shoes).
   - Dismisses lab members from the lab who have a major safety violation that could have been prevented (e.g., working on machinery while intoxicated) or repeated instances of unsafe work behavior (e.g., overloading circuits).

2. My lab manager/PI takes a proactive stance when it comes to safety. For example,

- Develops and institutes practices to deal with potential safety incidents before they occur (e.g., practices for avoiding electric shock).
- Emphasizes the importance of safety to all new lab members when they join the lab.
- Raises safety concerns when planning and developing research projects and studies.
- Considers the safety ramifications before introducing a new biological or equipment hazard.

3. Safety issues are openly discussed between my lab manager/PI and my workgroup. For instance, we
   - Discuss improper use of personal protective equipment (PPE) and other equipment in the lab.
   - Discuss proper handling and storage of lab materials and equipment.
   - Share lessons learned following a safety-related incident in our lab or other labs (e.g., severe injury and deaths caused by an electrical fire).

4. There is adequate safety training in my lab. Some of the things that we could be informed about and given initial and refresher training on include:
   - Standards and guidelines described in the following:
     - *TAMU Safety Manual: Electrical Safety*
     - *TAMU Safety Manual: Shop Safety*
     - *TAMU Office of Engineering Safety: Hand Tool and Power Tool Safety Checklist*
   - The nature of equipment hazards and how to protect ourselves.
   - How to respond to safety incidents ranging from minor to severe.

5. My co-workers always follow safety procedures. This includes
   The use of PPE:
   - Wear closed toe shoes and clothing that is not loose.
   - Do not wear loose fitting clothing, excessive jewelry, or keep long loose hair.
   - Don appropriate PPE when handling risky equipment (e.g., safety glasses, goggles, face shields, hardhat, etc.).

   Other standard mechanical/electrical safety procedures:
   - Operate equipment only after receiving necessary training.
   - Turn off power and unplug before working on electric or electric circuits.
   - Check wiring before turning on the power supply for a circuit or other electrical equipment.
   - Do not overload circuits.
   - Properly handle, store, and dispose batteries, cells, capacitors, and inductors.
   - Ensure adequate ventilation to prevent exposure to dust and fumes.
   - Ensure that tools and equipment are properly grounded and use tool and equipment guards.
   - Do not force power and machine tools when cutting.
   - Properly transporting and storing tools to ensure safety.
   - Never leave an unattended active tool or equipment running.
   - Ensure you are alert and attentive while handling dangerous machinery and never work alone.
   - Do not eat in the lab/shop.
   - Document safety-related issues and concerns (e.g., notify lab manager/PI about defective tools or equipment).

6. Equipment in my lab is checked to make sure it is free of faults (a list of <u>some</u> of the equipment and furniture that is likely to be in your lab is provided below).
    - Hand tools (e.g., axes, wrenches, hammers, chisels, screw drivers, saw blades, knives, etc.)
    - Power tools (e.g., saws, drills, cutting tools, welding equipment, solder, table saw, band saw, press, lathe, milling machine, etc.)
    - Hydraulically- or pneumatically-driven equipment
    - Batteries, cells, capacitors, inductors, or other storage devices.
    - Soldering irons
    - Electrical circuits
    - Electrical conductors
    - Lasers
    - Chemicals used for cleaning (e.g., ethanol alcohol, isopropyl alcohol, and acetone)
    - Ladders
    - Wiring and cords
    - Containers and carts
    - Base units and work tops
    - Storage cabinets

7. Unsafe conditions are promptly corrected in my work area. For instance,
    - The lab is cleaned regularly and clutter and debris including sawdust, wood chips, and metal chips are removed.
    - Batteries, cells, capacitors, and inductors are promptly and appropriately stored.
    - Defective or broken tools and equipment are promptly replaced.
    - Lights are replaced when they burn out.
    - Cutting tools are kept sharp.
    - Chemicals used for cleaning are promptly and appropriately stored.
    - Hazardous equipment and machinery are turned off when not in use.
    - Electrical circuits, components, and equipment are grounded before and after use.

8. My lab manager/PI promotes lab members' involvement in safety-related matters. This includes
    - Confer with us about safety concerns and new training for equipment (e.g., band saw) that may be needed.
    - Discuss with us the best way to comply with new safety regulations imposed by the university and regulatory agencies.
    - Seek input from my workgroup when developing new safety-related procedures (e.g., proper distance from machinery when in use).
    - Listen attentively to lab members' safety concerns and seek solutions.
    - Discuss safety in lab meetings.

9. My lab manager/PI praises safe work behavior. Some of the ways he/she might do this are
    - Provide positive feedback when working safely (e.g., proper use of PPE).
    - Recognize lab members for their safe behavior.
    - Give lab members who conduct safe work behavior more discretion and authority (e.g., they are allowed to operate more hazardous equipment).

APPENDIX F

HUMAN SUBJECTS/OFFICE LABORATORIES SAFETY CLIMATE MEASURE

Do you work in a human subjects laboratory? In these laboratories

- **humans are the subjects/participants**
- do NOT have a Biosafety Level (BSL) rating.
- Regulated by the Institutional Review Board (IRB)

Yes (direct to human subjects/office measure)

No (direct to next question)

Do you work in a computer laboratory? These laboratories

- DO NOT involve biological, chemical, or mechanical hazards
- may be in an **office-like environment**.

Yes (direct to human subjects/office measure)

No (direct to generic lab question)

Thinking of the research laboratory (lab) that you work in, the people you work with in the lab (co-workers), and the people you report to (lab manager, Principal Investigator (PI) of the lab), please read the statements listed below and mark the response that indicates the extent to which you agree with each statement.

Note – if YOU are a lab manager/PI please respond based on your own behavior.

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
1	2	3	4	5

1. My lab manager/PI strictly enforces the safe working procedures in my workgroup. This includes:
   - Corrects unsafe work practices (e.g., stops lab member from using a desk chair instead of a stepladder to reach materials up high)
   - Does not tolerate a deviation from safe work practices (e.g., reprimands lab members for creating tripping hazards with clutter)
   - Dismisses lab members from the lab who have a major safety violation that could have been prevented (e.g., starting a fire by placing a space heater near combustible material) or repeated instances of unsafe work behavior (e.g., leaving the lab unlocked at night).

2. My lab manager/PI takes a proactive stance when it comes to safety. For example,
   - Develops and institutes practices to deal with potential safety incidents before they occur (e.g., practices for avoiding electric shock).
   - Emphasizes the importance of safety to all new lab members when they join the lab.
   - Raises safety concerns when planning and developing research projects and studies.
   - Considers the safety ramifications before introducing an equipment hazard.

3. Safety issues are openly discussed between my lab manager/PI and my workgroup. For instance, we
   - Discuss improper use of equipment in the lab.
   - Discuss proper handling and storage of lab materials and equipment.
   - Share lessons learned following a safety-related incident in our lab or other labs (e.g., severe injuries caused by falling equipment).

4. There is adequate safety training in my lab. Some of the things that we could be informed about and given initial and refresher training on include:
   - Standards and guidelines described in the following:
     - *TAMU Safety Manual: Office Safety*
     - *TAMU Office of Engineering Safety: Office Safety*
   - The nature of equipment hazards and how to protect ourselves.
   - How to respond to safety incidents ranging from minor to severe.

5. My co-workers always follow safety procedures. This includes
   - Ensure all computers are off before moving or handling wiring.
   - Wear closed toe shoes when moving equipment.
   - Limit unnecessary clutter.
   - Avoid tripping hazards (e.g., upturned edges, frayed, or buckled carpets or mats, wet floors, uneven floors).
   - Avoid having too many plugs in an outlet.
   - Inspect and replace faulty wiring.

- Heavy files are stored in the bottom of filing cabinets.
- Large cabinets are secured to prevent tipping.
- Store material/equipment securely and such that they are easy to access.
- Use a stepladder rather than an office chair to reach materials up high.
- Document safety-related issues and concerns.
- Operate equipment only after receiving necessary training.

6. Equipment in my lab is checked to make sure it is free of faults (a list of <u>some</u> of the equipment and furniture that is likely to be in your lab is provided below).
   - Wiring
   - Extension cords
   - Computers
   - Stepladders
   - Copiers
   - Microwaves
   - Furniture including file cabinets, shelves, desks, and chairs
   - Office supplies

7. Unsafe conditions are promptly corrected in my work area. For instance,
   - The lab is cleaned regularly and clutter is removed.
   - Waste containers are emptied regularly.
   - Broken glass is carefully handled and disposed of.
   - Tripping hazards are taken care of.
   - Lights are replaced when they burn out.
   - Plugs are moved when there are too many in one outlet.
   - Hazardous equipment and machinery are turned off when not in use.
   - The lab is closed and locked when not in use.

8. My lab manager/PI promotes lab members' involvement in safety-related matters. This includes
   - Confer with us about safety concerns and new training for equipment (e.g., copier) that may be needed.
   - Discuss with us the best way to comply with new safety regulations imposed by the university and regulatory agencies.
   - Seek input from my workgroup when developing new safety-related procedures (e.g., safe storage).
   - Listen attentively to lab members' safety concerns and seek solutions.
   - Discuss safety in lab meetings.

9. My lab manager/PI praises safe work behavior. Some of the ways he/she might do this are
   - Provide positive feedback when working safely (e.g., bending at the knees to lift heavy boxes).
   - Recognize lab members for their safe behavior.

- Give lab members who conduct safe work behavior more discretion and authority (e.g., they are allowed to work in the lab independently).

APPENDIX G

GENERIC LABORATORIES SAFETY CLIMATE MEASURE

It appears that none of the questions we posed are descriptive of the research laboratory you work in. Please describe the lab that you work in including any hazards that you are exposed to: ________________________________ (direct to a generic lab safety measure)

Thinking of the research laboratory (lab) that you work in, the people you work with in the lab (co-workers), and the people you report to (lab manager, Principal Investigator (PI) of the lab), please read the statements listed below and mark the response that indicates the extent to which you agree with each statement.

Note – if YOU are a lab manager/PI please respond based on your own behavior.

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
1	2	3	4	5

1. My lab manager/PI strictly enforces the safe working procedures in my workgroup. This includes:
   - Corrects unsafe work practices (examples below)
     - Stops lab member from eating in the lab; stops a lab member from using an x-ray machine without their personal dosimeter; stops lab member from using a desk chair instead of a stepladder to reach materials up high
   - Does not tolerate a deviation from safe work practices (examples below)
     - Sends lab members home to change shoes if they are wearing open-toe shoes; stops lab member from using a desk chair instead of a stepladder to reach materials up high
   - Dismisses lab members from the lab who have a major safety violation that could have been prevented (examples below)
     - An injury caused by the improper use of machinery; an overexposure to high levels of radiation; leaving animal cages open; working on machinery while intoxicated; starting a fire by placing a space heater near combustible material) or repeated instances of unsafe work behavior (e.g., storing incompatible chemicals together; improper biohazardous material disposal; animal bites caused by improper handling; overloading circuits; leaving the lab unlocked at night

2. My lab manager/PI takes a proactive stance when it comes to safety. For example,

- Develops and institutes practices to deal with potential safety incidents before they occur (examples below)
    - Practices for avoiding electric shock; practices for avoiding accidental exposure to infectious agents; practices for avoiding inhalation of hazardous aerosols
- Emphasizes the importance of safety to all new lab members when they join the lab.
- Raises safety concerns when planning and developing research projects and studies.
- Considers the safety ramifications before introducing a new chemical or equipment hazard.

3. Safety issues are openly discussed between my lab manager/PI and my workgroup. For instance, we
    - Discuss improper use of personal protective equipment (PPE) and other equipment in the lab.
    - Discuss proper chemical handling, labeling, storage, and disposal.
    - Discuss proper biohazardous material handling, labeling, storage, and disposal.
    - Discuss proper animal care including handling, feeding, cage cleaning, and disposal.
    - Discuss proper handling and storage of lab materials and equipment.
    - Share lessons learned following a safety-related incident in our lab or other labs (examples below)
        - Severe injuries and deaths caused by improper chemical handling, exposure, falling equipment, or an electrical fire

4. There is adequate safety training in my workgroup. Some of the things that we could be informed about and given initial and refresher training on include:
    - Standards and guidelines described in the following:
        - Texas A&M EHS *Chemical Laboratory Safety and Hazard Communication Compliance Manual*
        - *TAMU Safety Manual: Chemical Safety*
        - Center for Disease Control's (CDC) *Biosafety in Microbiological and Biomedical Laboratories*
        - *U.S. Department of Health and Human Services NIH Guidelines for Research Involving Recombinant or Synthetic Nucleic Acid and Molecules*
        - *TAMU Safety Manual: Electrical Safety*
        - *TAMU Safety Manual: Shop Safety*
        - *TAMU Office of Engineering Safety: Hand Tool and Power Tool Safety Checklist*
        - *TAMU Safety Manual: Office Safety*
        - *TAMU Office of Engineering Safety: Office Safety*
    - The nature of chemical, biological (e.g., infectious) material, animal, and/or equipment hazards and how to protect ourselves.
    - Proper detection and response to a chemical or biohazard release.
    - How to respond to safety incidents ranging from minor to severe.

5. My co-workers always follow safety procedures. This includes
   The use of PPE:
    - Wear appropriate clothes in the laboratory (i.e., closed toe shoes, laboratory coat/smock, and full-length shirts and pants)
    - Don appropriate PPE when handling risky equipment, radioactive materials, chemicals, and biohazards (e.g., chemical splash goggles, gloves/gauntlets, hot mitts, aprons, respirators, face shield, hardhats, etc.).

- Wear closed toe shoes and clothing that is not loose.
- Do not wear loose fitting clothing, excessive jewelry, or keep long loose hair.

Other standard safety procedures:

- Use of biosafety cabinet when working with biohazards.
- Use of fume hoods when working with chemicals, radioactive material, and any other material that releases hazardous aerosols.
- Store, label, and date biohazards and chemicals appropriately.
- Dispose of chemical, biohazardous/infectious and/or animal waste properly.
- Respond and react to chemical and/or infectious material spills and releases according to procedures.
- Do not eat in the lab and do not store food with laboratory specimens.
- Do not pipette by mouth.
- Safety handling and disposal of sharps.
- Decontamination of equipment, workspaces, and infectious material.
- Document safety-related issues and concerns (e.g., notify lab manager/PI about defective tools or equipment).
- Operate equipment and/or work with animals only after receiving necessary training.
- Appropriate animal cage decontamination, cleaning, and washing.
- Turn off power and unplug before working on electric or electric circuits.
- Check wiring before turning on the power supply for a circuit or other electrical equipment.
- Do not overload circuits.
- Properly handle, store, and dispose batteries, cells, capacitors, and inductors.
- Ensure adequate ventilation to prevent exposure to dust and fumes.
- Ensure that tools and equipment are properly grounded and use tool and equipment guards.
- Do not force power and machine tools when cutting.
- Properly transporting and storing tools to ensure safety.
- Never leave an unattended active tool or equipment running.
- Ensure you are alert and attentive while handling dangerous machinery and never work alone.
- Wear closed toe shoes when moving equipment.
- Limit unnecessary clutter.
- Avoid tripping hazards (e.g., upturned edges, frayed, or buckled carpets or mats, wet floors, uneven floors).
- Avoid having too many plugs in an outlet.
- Inspect and replace faulty wiring.
- Heavy files are stored in the bottom of filing cabinets.
- Large cabinets are secured to prevent tipping.
- Store material/equipment securely and such that they are easy to access.
- Use a stepladder rather than an office chair to reach materials up high.

6. Equipment in my lab is checked to make sure it is free of faults (a list of <u>some</u> of the equipment that is likely to be in your lab is provided below).
    - Fume hoods
    - Incinerators

- Autoclaves
- Biosafety cabinets
- Centrifuges
- Lasers
- Hydraulically- or pneumatically-driven equipment
- Hand tools (e.g., axes, wrenches, hammers, chisels, screw drivers, saw blades, knives, etc.)
- Power tools (e.g., saws, drills, cutting tools, welding equipment, solder, table saw, band saw, press, lathe, milling machine, etc.)
- Batteries, cells, capacitors, inductors, or other storage devices.
- Soldering irons
- Electrical circuits
- Electrical conductors
- X-ray equipment
- Exercise equipment (e.g., treadmill, weightlifting equipment, stationary bicycles)
- Burners and hot plates
- Animal cages
- Cage washers (rack washer, cabinet washer, tunnel washer)
- Refrigerators/Freezers
- Compressed gas cylinders
- Distillations and condensers
- Ovens
- Heating baths
- Hydrostatic weighing tank
- Stills
- Glassware
- Chemicals used for cleaning (e.g., ethanol alcohol, isopropyl alcohol, and acetone)
- Ladders
- Wiring and cords
- Extension cords
- Computers
- Stepladders
- Copiers
- Containers and carts
- Base units and work tops
- Storage cabinets Microwaves
- Furniture including file cabinets, shelves, desks, and chairs
- Office supplies

7. Unsafe conditions are promptly corrected in my work area. For instance,
    - The lab (potentially including animal cages) is cleaned regularly and clutter and debris including sawdust, wood chips, and metal chips are removed.
    - Work surfaces and equipment are decontaminated promptly after completion of work.
    - Infectious material and chemical spills and releases and/or animal waste are promptly taken care of.
    - Biohazards, chemicals, and/or radioactive material are promptly and appropriately stored.
    - Hazardous equipment and machinery are turned off when not in use.
    - Electrical circuits, components, and equipment are grounded before and after use.
    - Sharps and broken glassware are promptly disposed of.
    - Work surfaces and equipment are decontaminated promptly after completion of work.
    - Batteries, cells, capacitors, and inductors are promptly and appropriately stored.
    - Defective or broken tools and equipment are promptly replaced.
    - Lights are replaced when they burn out.
    - Cutting tools are kept sharp.
    - Waste containers are emptied regularly.

- Broken glass is carefully handled and disposed of.
- Tripping hazards are taken care of.
- Plugs are moved when there are too many in one outlet.
- The lab is closed and locked when not in use.

8. My lab manager/PI promotes lab members' involvement in safety-related matters. This includes
    - Confer with us about safety concerns and new training for equipment (e.g., laser, band saw, x-ray machine, copier) that may be needed.
    - Discuss with us the best way to comply with new safety regulations imposed by the university and regulatory agencies.
    - Seek input from my workgroup when developing new safety-related procedures (e.g., proper disposal of radioactive and/or biohazard waste; handling animals; proper distance from machinery when in use; safe storage).
    - Listen attentively to lab members' safety concerns and seek solutions.
    - Discuss safety in lab meetings.

9. My lab manager/PI praises safe work behavior. Some of the ways he/she might do this are
    - Provide positive feedback when working safely (e.g., proper use of PPE; bending at the knees to lift heavy boxes).
    - Recognize lab members for their safe behavior.
    - Give lab members who conduct safe work behavior more discretion and authority (e.g., they are allowed to operate more hazardous equipment; they are allowed to work in the lab independently).

APPENDIX H

PERCEIVED RISK AND SAFETY PREDICTORS

Self-report injuries, incidents, and near misses

In the last 12 months, how many times have you been injured while working in the lab (any kind of injury including a scrape, cut, burn, etc.)? ___________________
In the last 12 months, how many incidents have you had that did NOT result in injury (e.g., equipment damage, chemical release)? ___________________
In the last 12 months, how many near misses or near accidents (i.e., incidents that could have resulted in harm to persons or equipment but did not) have you had (e.g., improper use of PPE, lab left unlocked)? ___________________

Perceived job risk

Please mark the response that indicates the extent to which each statement is true.	Almost Always Untrue	Often Untrue	Sometimes Untrue/Sometimes True	Often True	Almost Always True
1. I encounter personally hazardous situations while in the laboratory.	1	2	3	4	5
2. My job in the lab is physically dangerous.	1	2	3	4	5
3. I am directly exposed to physical harm in carrying out my job in the lab.	1	2	3	4	5

Safety participation

Please mark the response that indicates the extent to which you agree with each statement.	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
1. I promote safety within the laboratory.	1	2	3	4	5
2. I put in extra effort to improve the safety of the laboratory.	1	2	3	4	5
3. I help my co-workers when they are working under risky or hazardous conditions.	1	2	3	4	5

Please mark the response that indicates the extent to which you agree with each statement.	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
4. I voluntarily carry out tasks or activities that help to improve laboratory safety.	1	2	3	4	5

Safety knowledge

Please mark the response that indicates the extent to which you agree with each statement.	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
1. I know how to perform my job in the lab in a safe manner.	1	2	3	4	5
2. I know how to use safety equipment and standard laboratory procedures.	1	2	3	4	5
3. I know how to maintain or improve laboratory health and safety.	1	2	3	4	5
4. I know how to reduce the risk of accidents and incidents in the laboratory.	1	2	3	4	5

Safety compliance

Please mark the response that indicates the extent to which you agree with each statement.	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
1. I carry out my work in the lab in a safe manner.	1	2	3	4	5
2. I use all the necessary safety equipment to do my job in the lab.	1	2	3	4	5
3. I use the correct safety procedures for carrying out my job in the lab.	1	2	3	4	5
4. I ensure the highest levels of safety when I carry out my job in the lab.	1	2	3	4	5

APPENDIX I

LAB-SPECIFIC QUESTIONS AND DEMOGRAPHICS

1. At what level is your current position in the lab?

- Undergraduate student
- Graduate student
- Post-doc
- Lab manager (not a student or post-doc)
- Research Scientists
- Research Associate
- Principal Investigator (PI)
- Other (____________________________)

2. Approximately, how long have you worked in your current lab (in months)?

____

3. Approximately, how many members are in your lab (including yourself)?

____

4. If you have worked in a laboratory at another university, please indicate the extent to which you feel safer in your TAMU lab.

- N/A (I have never worked in another lab)
- Much Less Safe
- Somewhat Less Safe
- Equally Safe
- Somewhat More Safe
- Much More Safe

5. What is your race?

- African-American/Black (not Hispanic or Latino)
- American Indian or Alaska Native (not Hispanic or Latino)
- Asian (not Hispanic or Latino)

- Latino or Hispanic
- Native Hawaiian or Other Pacific Islander (not Hispanic or Latino)
- White (not Hispanic or Latino)
- Other heritage ______________________________

6. What is your sex?

- Male
- Female

7. What is your age in years?

____